Herman A. Karl · Lynn Scarlett
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Michael Flaxman *Editors*

Restoring Lands - Coordinating Science, Politics and Action

Complexities of Climate and Governance

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Preface

Our book is intended to inspire dialogue on new and creative ways to achieve harmony among ecological, social, and economic systems. We would urge you to read William Isaac's book, *Dialogue and the Art of Thinking Together*, either before or after reading this book to relate better to our message.[1] Out of these dialogues, perhaps, will evolve a new *ethos* and *ethic* with respect to the environment that will spur a movement for change and action:

> To affirm each person's dignity
>
> And to cherish the living earth

These two lines are simple yet incredibly powerful statements. They are the last two lines of the four-line Call to Ministry of the First Parish in Lincoln, Massachusetts the small New England town where Herman Karl lives.[2] Instilling a reverence for the living earth in people and respecting each other's dignity are the keys to sustaining a healthy environment for future generations. This is the foundation upon which regulations, economic coalitions, and stewardship needs to be built.

Our relationship with nature cannot be defined in technical terms; it is spiritual and aesthetic.

In writing this book we have reached back to some older works including those by Henry David Thoreau and especially Aldo Leopold. So that their message is not lost in the pages that follow and that you can reflect upon them as you read, we

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[1] Other books that help to provide a good foundation for better understanding the underlying premise of this book include: *Frame Reflection* by D.A. Schon and M. Rein and *The Reflective Practitioner: How Professionals Think in Action* by D.A. Schon.

[2] Roger Paine, the minister, opened the service the Sunday morning that Herman Karl first heard these lines by telling about his vacation to Pt. Reyes National Seashore and the beauty of the emerald green hills filled with wild flowers brought to life by the recent rains. Pt. Reyes is part of the Tomales Bay watershed, which is described in Chapter 20. His sermon was on Moral Reasoning. He talked about people getting so caught up in doing "right" that they forget about doing "good."

presage a few key passages from subsequent chapters that particularly bear on humankind's relationship with nature and a new environmental ethos.

Thoreau states in Walden (Sayre 1985, 490):

> Fisherman, hunters, woodchoppers, and others, spending their lives in the fields and woods, in a peculiar sense a part of Nature themselves, are often a more favorable mood for observing her, in the intervals of their pursuits than philosophers or poets even, who approach her with expectation. She is not afraid to exhibit herself to them. … We are most interested when science reports what those men already know practically or instinctively, for that alone is a true humanity [emphasis original], or account of human experience.

With respect to scientific and technical solutions to restoring lands and the need to rethink approaches, Leopold made a sage observation decades ago (Meine 1988, 383):

> 'We end,' Leopold concluded, 'at what might be called the paradox of the twentieth century: our tools are better than we are, and grow better and faster than we do. They suffice to crack the atom, to command the tides. But they do not suffice for the oldest task in human history: to live on a piece of land without spoiling it.'

In *Thinking Like A Mountain*, he describes the killing of a pack of wolves and alludes to the spiritual relationship between humankind and nature (Leopold 1949, 130).

> We reached the old wolf in time to watch a fierce green fire dying in her eyes. I realized then, and have known ever since, that there was something new to me in those eyes—something known only to her and to the mountain.

With regard to restoring and preserving lands (224–225),

> A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.

And humankind's relationship to the land (203–224),

> All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts. … The land ethic simply enlarges the boundaries of that community to include soils, waters, plants, and animals, or collectively: the land.

Holling and Chambers (1973) in a seminal paper help us to transition into the modern era of social-ecological systems thinking, resilience, and new forms of governance and institutional arrangements.

In the past, ecosystems and communities have been sufficiently resilient to absorb the impacts of natural disturbances and human activity.

> "… resilience is not infinite" and "…three hundred years of ignoring these limits has left us with a baggage of approaches and solutions that are only admirable as instruments for resolving fragments of problems. Wherever we look there are gaps – gaps between methods, disciplines, and institutions."

This book identifies the gaps and offers approaches to bridge them. American political institutions are reasonably adept at dealing with crises. They are not suited well at all for the ongoing, flexible, and adaptive policy formulation and decision-making required for balancing the dynamics of coupled natural and human systems for sustainability, which pose wicked problems. We show how what we already know and practice can be framed, structured, and integrated into a holistic approach to tackle the wicked problem of sustainability. We suggest the creation of new institutions and spaces for adaptive policy formulation and decision-making, because it is not the problem that is wicked so much as the response to it. Whereas these need to be a collaborative effort between government and citizens, the impetus will come from grass roots movements that are emerging organically across the nation and the globe.

Like living organisms, and the earth itself, these new institutions ought to constantly evolve – they must, as wicked problems constantly morph and have no discrete solution only better or worse outcomes.

> We shall never achieve harmony with the land, anymore than we shall achieve absolute justice or liberty for people. In these higher aspirations the important thing is not to achieve but to strive (Aldo Leopold).

Acknowledgements

Herman Karl Many people, too many to name individually, contributed to shaping the evolution of my thinking about restoring and sustaining lands. I am indebted to several visionary leaders that took a risk and supported me to pursue what was an unconventional path of research in the U.S. Geological Survey as my interests evolved from basic marine geological research to the use of science in policy formulation and natural resource management. Gordon Eaton, 12th Director of the USGS, appointed me to the bureau Strategic Planning Team in 1994–1995. This provided an opportunity to learn about USGS as an institution and to help shape its future. P. Patrick Leahy, first as Chief Scientist of the Geologic Division and subsequently as Associate Director for Geology and Acting Director, provided both moral and financial support. I will never forget Pat's remarks to me when I called to discuss the unusual line of research I proposed to undertake. After about 2 min, he said, "Stop, I understand exactly what you want to do and the great risk it entails. I also understand the great potential pay-off to this organization, and I will fund you for 3 years." Charles "Chip" Groat, the 13th Director of the USGS, continued additional venture capital funding as part of the Science Impact Program and encouraged me to expand my research. Alan Mikuni, Chief of the Western Geographic Science Center, provided a space for me to experiment and a safety net to fail when I transferred from the Geology Discipline to the Geography Discipline.

Robert Barrett, an environmental mediator, in California introduced me to the field of collaboration and consensus building. Through Bob, I met Prof. Lawrence Susskind of the Massachusetts Institute of Technology. Larry invited me to MIT on a sabbatical. USGS approved a 1-year temporary assignment that turned into a permanent change of duty station and a 7-year stay at MIT as a Visiting Lecturer in the Department of Urban Studies and Planning. Larry and I co-founded and co-directed the MIT-USGS Science Impact Collaborative (MUSIC). Carl Shapiro, my good friend and colleague in USGS, persevered with me through the bureaucratic morass to move the MUSIC experiment forward; we faced many trials and tribulations together.

During my transition from physical scientist to social scientist (at least that's what I've been told I am now), Gary McVicker and Charles Pregler invited me to be an instructor in the Bureau of Land Management's Community Based Ecosystem Stewardship course. More than anything else, this singular event changed my outlook on the role of science and scientists in ecosystem restoration and introduced me to citizen stewardship. The many hard working people that came together despite their differences because they cared about the land taught me more than I could possibly teach them.

During this period of transition in my career, I met Michael Mery, then chair of the Tomales Bay Watershed Association. He and the dedicated people that confronted their conflicts, turning them into creative solutions to preserve the character and qualities of the place they loved further inspired me to help develop participatory, collaborative approaches to harmonize the ecological, social, and economic systems.

Throughout all, working quietly and sometimes not so quietly in the background, Lynn Scarlett, my co-editor and friend, supported my efforts through her position first as Assistant Secretary for Policy, Management, and Budget and later as Deputy Secretary in the Interior Department.

Most of all it is through the ongoing support and encouragement of my wife, Suzanne that I have been able to continue to move forward. She has always had faith in me. My daughter, Chantelle, has been an inspiration for me to search for ways to achieve sustainability. As one of her elementary school teachers commented, "Chantelle has a reverence for all life."

Finally, I dedicate this book to the memory of my deceased parents. They instilled in me a moral compass, integrity, inquisitiveness, initiative, responsibility, and ensured that my education came first and foremost. Mostly they encouraged me to be myself.

Lynn Scarlett There is an Apache blessing that closes with these words: "May you walk gently through the world and know its beauty all the days of your life." Behind the analysis and narratives of this book lies, for me, fundamentally, the beauty of this world – a beauty of both people and places. I thank my mother for opening my heart to this beauty. I thank my daughter for lighting my days with laughter and learning to laugh at myself. I thank so many, many colleagues at the Department of the Interior for connecting me to so many people and places laying caring hands across America's landscapes. I thank them, too, for sharing their wisdom. I thank Steven, John, and Maryanne for sharing with me the delights of dragonflies, butterflies, birds, and all things wild.

Michael Flaxman My love of nature comes from my mother, who made sure that I was educated about natural history, even though it was clear at a young age that I didn't share her green thumb. My love of planning comes from my father, who helped start the planned community of Reston, Virginia, where I grew up. Neither of them have much patience for computers, so I'm not sure what sparked my interest there. Combining these three things took awhile, since geographic information systems hadn't been invented when I went to school. I am grateful to ecologist Michael Hamilton, landscape architect David Hulse, and planner Carl Steinitz for showing me that useful and interesting things can be done in this area. They taught me that when you start with love of place, and respect for its people, flora and fauna, you can always find your way to the knowledge and methods needed. Along the way, you often get to meet some exceptional people.

The work presented here represents passion, dedication, and commitment to doing things better, often against trying odds. As a starting professor at MIT, I particularly appreciate the role of Herman Karl in providing what I found to be a vital bridge between theory and practice, and the communities of science and planning. Although the road was frequently rocky, he stuck true to a vision about what was important, even when it might be hard.

Along a similar vein, my research colleague Juan Carlos Vargas-Moreno has suffered through more bureaucracy, contracting battles and even office-space shuffling in the last 3 years than anyone should have to deal with over a lifetime. So I am thankful to him for his persistence in getting the work done well, even under the most challenging circumstances. Looking back, I am proud of what we have accomplished, despite working on a shoestring with incredibly limited resources.

The students and volunteers working under our supervision, often for long hours and doing something far outside their professional training largely accomplished the Everglades research project. This included undergraduate research assistants, Masters in Community Planning (MCP) graduate students, a Ph.D. student and a visiting researcher. They are individually credited in our chapters, but I want to thank them here again, since none of this could have been done without them.

The project itself would not have been possible without the visionary leadership provided by three exceptional public servants. Ronnie Best, of USGS, had the original vision, which led to the study. Dr. Best is a model to me of what I would most hope for from our nation's scientific leadership. He is a scientist's scientist who thinks outside of the box. In our project and others, he continues to invest significant resources into the challenging and often thankless task of making sure good science leads to better planning. Paul Souza, from the U.S. Fish and Wildlife Service, was the rare manager willing to take a risk, granting us the resources and precious staff time to address a long-term problem while short-term fires raged around him. Steve Traxler was our main FWS liaison, champion, and interagency cultural translator. It is hard to overstate the importance of his support in holding things together and allowing us to move forward. All three of these folks went far outside of their job descriptions to ensure project success.

Finally, thanks to my very patient wife, who endured Boston winters while I was off working in Florida, and frequent cold dinners even when I was at home, all so that I could work overtime on this project and book.

Juan Carlos Vargas-Moreno "This is a place for hope Juan Carlos, as well as place for meditating about the miracle of life," my father said, as I started my first hike in the deepest of the rain forest…I was only 6, my father a young biology professor; the place was my home country Costa Rica. That is my recollection of an appreciation for nature and the land around land.

I need to first and foremost acknowledge my father Gerardo and my mother Maria Teresa for teaching me to appreciate life through the beauty of our land and our relationship with it. To my father who was successful in imbedding in the deepest place of my heart the appreciation and love for nature. To my mother for supporting me and making me aware of life choices and disciplines that eventually allowed me to help conserve that land. I own them my academic and scholar interest. Thanks for a lifetime of ongoing and unconditional support. To my home country Costa Rica for letting me enjoy nature in a very special way as a child.

I also to thank Carl Steinitz my academic mentor for an education beyond the Harvard classrooms and for countless hours of work and discussion together about land, nature and how to plan for their future. Similarly I want to thank Richard Forman at the Harvard Design School for teaching me to see the natural world through the lenses of the landscape itself; and to Bill Clark at the Harvard Kennedy School for teaching me to see land conservation not only as a planning and scientific problem but also as a societal one.

Many people have contributed in the elaboration of this book. First I want to thank my colleagues Herman Karl, Lynn Scarlett and Michael Flaxman, for their patience and incredible discussions lading to this book. To our chapter contributors for pouring their souls and years of experience into these pages, as well as tolerating our edits and sharing a vision for what this book should explored. Thank you all for an incredible job.

My special gratitude goes to Ronnie Best (USGS), Paul Souza and Steve Traxler (USFWS) three outstanding leaders at these federal institutions, for believing and supporting our research vision. Several of these book chapters would not be possible without them. Your leadership and professionalism is a source of insipiration for all of us.

I want to thank the Department of Urban Studies and Planning at MIT for the continued support and especially to our department chair Amy Glasmeier, and those colleagues at the Environmental and Policy Planning Group. I specially want to thank my colleague Michael Flaxman, for the endless support, advice and friendship for the last 10 years. Our intellectual exchanges have always nurtured my work. Also to Herman Karl, for his energy, unbreakable ethics and persistence from which I have learned a great deal. Thanks for believing in our work. Great appreciation goes to our students at MIT, thanks for your patience and valuable work.

Finally, I want to thank my soon to be wife Karelys for her unconditional support, endless patience and most importantly for believing in me. Te amo mi amor. Nothing would mean the same with you.

Contents

Part I
Introduction

Chapter 1
Restoring and Sustaining Lands—Coordinating Science, Politics, and Community for Action

Herman A. Karl, Lynn Scarlett, Juan Carlos Vargas-Moreno, and Michael Flaxman

Abstract We propose that a new conceptual framework is needed for conservation and land restoration to achieve sustainability. We present two conceptual models—Static Productive Harmony and Dynamic Productive Harmony—for formulating environmental policy and making natural resource management decisions. The static model seeks a balance among ecological, social, and economic systems through compromises that require trade-offs that often end up satisfying no one. The dynamic model represents a fundamentally different approach to restoring and sustaining lands. In this model, healthy ecosystems are the foundation for thriving communities and dynamic economies. The dynamic model aims to generate resource management approaches that add value to each of the systems for a mutual gains outcome. Restoring and sustaining lands is a wicked problem. New institutions need to be shaped that support ongoing collaborative and participatory processes to achieve durable and equitable environmental policy.

Keywords Ecosystem health • Land restoration • Collaboration • Land ethic • Wicked problems • Trust • Relationships • Productive harmony

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"For the first time, I understand the benefits to my family's welfare to manage my ranch for a healthy ecosystem. More importantly, I recognize the responsibility I have to all of society to restore my land and maintain it as a healthy ecosystem."[1] The rancher that made this statement experienced an epiphany. He gleaned an insight that is the underlying premise of this book—healthy ecosystems are the foundation for thriving communities and dynamic economies. He came to understand that his economic wellbeing and his family's quality of life depend upon restoring the natural environment of his ranch. That same link between economies and the environment applies broadly across communities. Sustainability is an illusion unless communities understand the importance of restoring lands to health and protecting the environment and *manifest their understanding through action*.[2]

This book gives voice to others like the Nevada rancher. It is not an academic tome, although some contributors are with academic institutions. And it is not a guide book or handbook by practitioners setting out procedures and methods for collaborative conservation. It is a narrative of diverse voices that collectively talk about coordinating science, politics, and communities to manage ecosystems in harmony[3] with social and economic systems. The common thread through each of the chapters is the belief in the effectiveness of *people acting together* to achieve durable solutions for restoring lands. Each of the authors, who generically might be classed as "scholar practitioners," has a very different background, set of experiences, and career path—engineer, social scientist, political scientist, physical scientist, biologist, ecologist, natural resource manager, policy maker, activist citizen, federal government scientist, urban planner, landscape architect, computer modeler—yet their paths led each of them to embrace the promise and power of collaboration and the ability of people to express their diverse values in grappling with complex and contentious environmental and land use issues.

These chapters provide some insights as to why and how the individual paths of participating authors converged. Although each chapter stands alone and can be read independently of the others, a greater understanding will come through reading the book in its entirety. We will help the reader in that understanding by linking each chapter in each section, linking each section, and concluding with a synthesis and recommendation for a more effective process that coordinates science, politics and communities to restore and sustain lands. In this regard, the appendix will help you understand how these concepts translate into action on the ground.

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[1] A rancher in eastern Nevada said this to Herman Karl about in 2004 when Karl was visiting two privately held ranches that practiced holistic ranch management.

[2] The challenge is not only that of action; it is how to develop institutions that provide the incentives, feedback, and accountability that help people understand the results of their decisions, be accountable for them, and adjust to changing circumstances.

[3] Thoreau provided a view of harmony in Walden published in 1854 that is as true today as it was then: "Our notions of law and harmony are commonly confined to those instances which we detect; but the harmony which results from a far greater number of seemingly conflicting, but really concurring, laws which we have never detected is still more wonderful" (Sayre 1985). Has he anticipated the field of ecology and Leopold's land ethic?

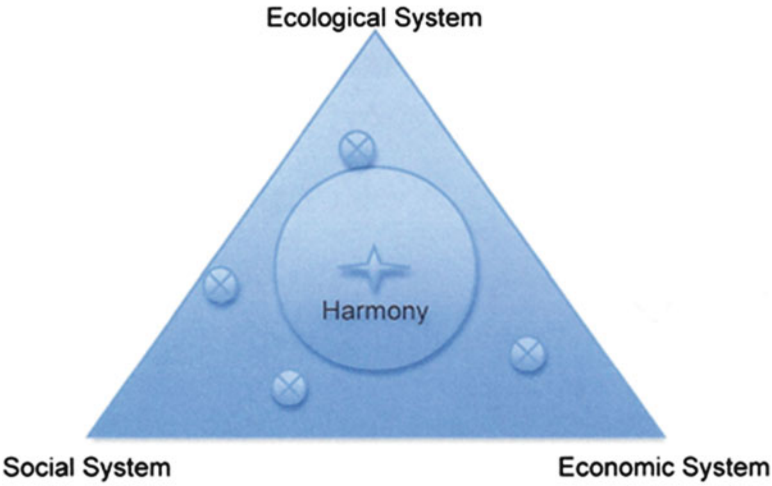
Since the environmental crises of the 1960s, societies have endeavored to find ways to manage natural systems and the services they provide in harmony with social and economic systems. Enacted in 1969, the foundational modern U.S. environmental law, the National Environmental Policy Act (NEPA), sets forth this aspiration and outlines the decision processes that are intended to help federal agencies better achieve "productive" harmony among ecological systems, economic systems, and social systems. At least two decades of sustainability initiatives, likewise, have aimed for this harmony. Yet these efforts continue to fall short of their aspirational promise. One increasingly apparent barrier pertains to governance processes and institutions, which this book addresses in several chapters. Another fundamental barrier is the tension between the environment and the economy[4] (Layzer 2006).

Productive harmony is most often interpreted to imply an equal status among the three systems. However, one worldview puts economic systems and societies they support on a higher plane than ecological systems, whereas another worldview elevates ecological systems. These opposing worldviews generate conflict, which often results in dysfunction, because the antagonists on one side presume robust economies are attained at the expense of ecosystem health (despoiling the environment) and those on the other side believe aggressive environmental protection and ecosystem restoration are not compatible with strong (profitable) economies. Some actions to reduce environmental impacts do carry costs, and most production and consumption activities have some environmental impacts. However, pursuit of economic and environmental benefits need not be a zero-sum contest. Such a framework presents an unnecessary dichotomy. Adherence to it causes polarization and stalemate. The potential tensions between economic actions and environmental protection, when managed well, can transform into a creative tension that can lead to breakthrough solutions—the harmony among ecological, economic, and social systems envisioned in the National Environmental Policy Act. The chapters in this book illustrate various ways for turning potentially bitter and deadlocked disputes into *actionable, productive, and durable outcomes that address environmental, economic, and social goals*.

Implicit in this book is the belief that healthy lands are the foundation for thriving communities and dynamic economies,[5] as stated in the opening paragraph. The conventional conception of productive harmony among the three systems is that each system occupies the corner of a triangle or some other trilogy analogy (Fig. 1.1, Static Productive Harmony model). Productive harmony, or sustainability, is achieved at the center of the triangle, which seldom occurs in practice. There are various paths and combinations to reach the harmonious center, yet these paths often require trade-offs that can possibly (and often do) result in deadlock. Theoretically, productive harmony could be achieved at numerous

[4] "Civilization has so cluttered this elemental man-earth relationship with gadgets and middlemen that awareness of it is growing dim. We fancy that industry supports us, forgetting what supports industry."— Aldo Leopold

[5] "We abuse land because we see it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect."—Aldo Leopold



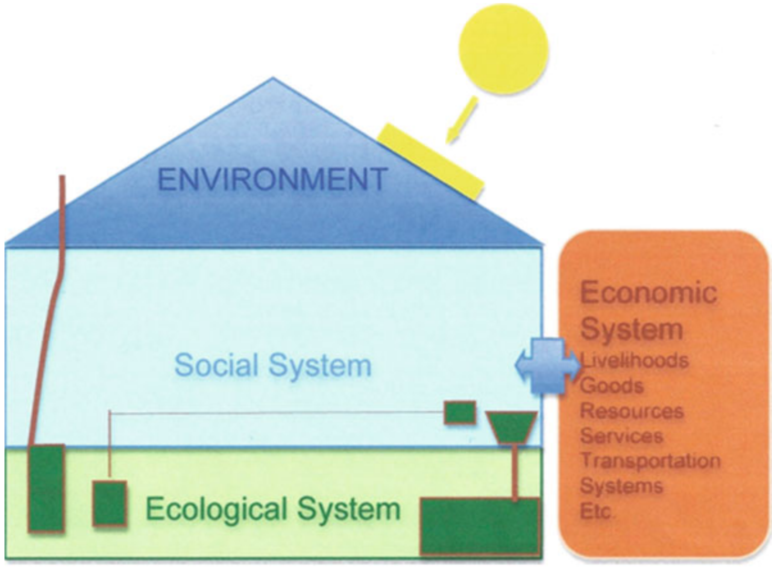
Static Productive Harmony Model

Fig. 1.1 This is a representation of the traditional way of thinking of harmony among ecological systems, social systems, and economic systems. The *dots* with crosses represent a few of the infinite combinations within the circle among the three systems. This is a static model, with movement only possible within the bounds of the triangle, with sustainability essentially conceived as a series of different tradeoffs

points along these paths through compromise. But compromise is difficult to achieve, particularly where mistrust flourishes and, where decision making remains framed within the triangle of competing systems, there is no way to think outside the "box."

Another way to visualize productive harmony is to look at sustainability as a house (Fig. 1.2). In this conceptual model, Dynamic Productive Harmony, ecological systems are the foundation of the house and the heating, plumbing, electrical, and water systems (infrastructure) of the house; social systems are the living spaces (superstructure); and economic systems are the flows of goods and services such as food and fuel into the house to service the living spaces.[6] The engines (ecosystem services) for the infrastructure are housed in the basement, the structural foundation of the house. The environment is the overall framework of the house that shelters all. A deteriorating framework exposes everything within the house to the weather, with degradation or even, ruination resulting. Similarly, if the foundation is faulty or allowed to deteriorate, the superstructure and flow of goods and services will eventually deteriorate. Indeed, if the foundation has been neglected, a nicely painted house may provide a

[6]Ecological systems are both foundations and infrastructure. Using ecosystems in an ecosystem services framework is often about replacing "gray" infrastructure—levees, wastewater treatment plants, etc.—with "green" infrastructure—coastal sea marshes, wetlands, etc. Economic systems are not really just matters of "static" infrastructure—bridges, roads, airports, etc. As systems, economies are highly dynamic contexts through which people exchange goods and services, allocate scarce resources, etc.



Dynamic Productive Harmony Model

Fig. 1.2 In this conceptual model the ecological system is the foundation and infrastructure for robust social systems and strong economic systems. Sustainability is not possible without a healthy ecosystem. This is a dynamic model reflecting the complex and complicated dynamics of coupled natural and human systems. The "*house*" needs constant upkeep and if the needs of the family (society) change it can be expanded and remodeled. It is a dynamic, process-oriented model. Sustainability is attainable as an outcome of continual decision-making processes

false sense of security. The house must be constantly maintained (a continuing process) to stay in good repair. Given a strong foundation, the house can be remodeled and enlarged—breaking out of the original "box." The architect (scientist/engineer), general contractor (policy maker/economic actors), subcontractors (natural resource managers/land use planners), and owner (citizen/community) together can create something new to fit the growing needs of the family (society/nation).[7]

The distinction between these conceptual models is critical as they represent two fundamentally different approaches to restoring and sustaining lands and setting environmental policy. Following the first conceptual model, policy tends to move toward compromise among the three systems by seeking the center of the triangle, equating harmony as balance, but generally requiring tradeoffs among systems. Trade-offs are presumed at the expense of one system over another. In the second, policy focuses on sound construction and preservation of the foundation and the overall decision framework to sustain and preserve the superstructure, infrastructure, and resource flows. Trade-offs may still be necessary in this model. However, value can be added by "remodeling" mitigating trade-offs. Others have described this

[7] Anyone who has built a house knows that there is constant negotiation and tension among the architect, contractor, subcontractors, and owner. When tension is managed well, a superior house is built.

intersection of environmental, economic, and social values as achieving "triple bottom line" or win-win-win outcomes.

The recognition that natural resources—the environment—must be conserved for the wellbeing of future generations emerged at the turn of the nineteenth century. President Theodore Roosevelt designated thousands of acres as national parks and national forests. The Progressive Movement reflected in these designations was, in part, a reaction to what was perceived as an over-exploitation of natural resources during the middle of the nineteenth century. He and America's first professional forester, Gifford Pinchot, introduced the concept of scientific management into the federal agencies and policy apparatus. The objective nature of science was thought to counter subjective and partisan politics as factors in making decisions about the management of natural resources. Yet this perspective has at least two limitations. First, the conduct of science itself is situated within value frameworks that shape (and may limit) the questions addressed through scientific inquiry. Second, resource management decisions involve matters linked to personal and social values, preferences, and priorities—such issues are not purely technical. To overlook these constraints can result in unintended consequences.[8] "Just because an idea is true doesn't mean it can be proved. And just because an idea can be proved doesn't mean it is true. When the experiments are done, we still have to choose what to believe" (Lehrer 2010, 57).[9]

Choosing what to believe is a function of values, worldviews, and cultural norms; people with different worldviews may hold the same values, but they may weigh each value differently. One's choices can change as one's life experiences accumulate and thinking evolves. The career of Aldo Leopold is exemplar in this regard (Meine 1988). Leopold was trained at the Yale School of Forestry in the scientific method of land management. Early in his career, he practiced the utilitarian principles of multiple uses of forests; forests were surveyed and trees counted to assess

[8] Karl was an instructor in the Bureau of Land Management Community-based Ecosystem Stewardship course; he taught the role of science in collaborative processes. These courses were taught at sites of some of the most contentious environmental issues in the country. He would start by asking the participants what they thought of and what their experience had been with science and scientists. A few people would say: "Smart people." "People in white lab coats." Many, though would say: "Lying SOBs." "You can't trust them as far as you can throw them." "You can pay any one of them to say anything you want." Clearly, their experiences with scientists and the information they produce were not that of objectivity. This experience was an epiphany for Karl. Every scientist that he has related the story too, has expressed shock. Too many scientists stay in their offices, laboratories, and discount local knowledge when in the field. More scientists should work with people to experience problems from their perspectives. Scientists might then take a more humble attitude toward their science and knowledge (see for example, Andrews 2002).

[9] The issue is not whether to "believe" experimental results per se. Indeed, science is all about a method of replication to try to validate results, rendering them (potentially) more robust. Rather, the issue goes back to the matter of different cognitive and decision purposes. Science is about asking, "how does the world work." But social and political choices are about "what values do we hold, what priorities do we hold, what are our individual preferences." Science cannot answer these questions. For example, scientists can examine what happens if some contaminant enters the soil. They can't answer the question: how clean is clean enough, which is a values question.

number of board feet that could be harvested in a sustainable way. Game (wildlife was a term not then used) management consisted of protecting prey species and killing predators. The field of ecology was not yet invented. Gradually and progressively Leopold began to understand that species were not isolated but connected as part of a complex biotic system and that it is the system (the environment) that must be preserved; disturbing any one part causes unbalance and dysfunction throughout the ecological system. But he understood more—he understood that science was not enough. In *Thinking Like A Mountain*, he describes the killing of a pack of wolves (Leopold 1949, 130). "We reached the old wolf in time to watch a fierce green fire dying in her eyes. I realized then, and have known ever since, that there was something new to me in those eyes—something known only to her and to the mountain." His personal evolution was cut short by an untimely death fighting a fire in 1948. His prescient work culminated in the *Land Ethic* (Leopold 1949). With regard to restoring and preserving lands, "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise (224–225)." Notably Leopold states, "I have purposefully presented the land ethic as a product of social evolution, because nothing so important as an ethic is ever 'written'. … I think it is a truism that as the ethical frontier advances from the individual to the community, its intellectual content increases" (225).

With this simple yet profound statement, Leopold had captured the essence of advances in social-ecological system thinking to the present day. Today we talk in terms of resilience, emergent properties, and dynamics of coupled natural and human systems (Gunderson et al. 1995; Folke et al. 1998; Gunderson and Holling 2002; Gunderson and Pritchard 2002; Berkes et al. 2003; Liu et al. 2007). The enhanced scientific and conceptual understandings of social-ecological systems are effectively refinements of Leopold's land ethic; and even with all the scientific advances, application of these concepts to environmental policy remains elusive. We need to make routine the processes that have been developed that teach us how to learn (double-loop learning; Argyris and Schon 1978), to learn from doing, and to make mid-course adjustments in our decisions based on what we learn. Research and analysis remains important so that we continue better to understand complex, dynamic ecosystems. Above all, however, we need better ways to strengthen linkages of science with experiential knowledge and to enhance processes and institutions that facilitate dynamic decision-making. We need to nurture the *political and social will to undertake the hard work of collaboration, and, particularly, to shape the institutions, policy tools, and science support that sustain collaborative action over time.*

We hope to advance the social evolution of the land ethic by inspiring our readers to reflect upon their relationship with the environment and to *take action to reflect that land ethic in decision making processes and resource management choices*.[10]

[10]Climate change has accelerated the need for society to evolve socially and to continue to develop a land ethic that instead of economics is the basis for political and social action. We must find ways to adapt to changing climate. We must evolve a new mindset that jumps beyond the bounds of the current environmental movements, which seem to have ground to a halt only staying the line and not moving further toward the goal.

To do this, we need to nurture a *new ethos* with respect to people's relationships to nature and the governance and management of natural resources and ecosystems; Nurturing the sort of land ethic Leopold and others have described will take generations of institutional evolution and experience.[11]

Beyond the challenges of reorienting how we think about the interrelationship of social, economic and environmental systems, land and resource managers face another conceptual challenge. Restoring and sustaining lands are wicked problems (Rittel and Webber 1973; Miller 1999; Ison and Collins 2008; Brown et al. 2010) because they require decisions at the interface of science, engineering and technology, governance and policy, ecology, culture, values, and livelihoods. We have described the possibilities of blending environmental, economic, and social values in land and resource management decisions. However, even where this blending may be possible, many land and resource management issues are "wicked problems" that have no solution only better or worse outcomes. In part, they are wicked problems because these problems unfold within highly dynamic physical, social, and political contexts. Change is often nonlinear and, hence, not readily predicted. Moreover, many of these problems involve multiple physical variables and many potentially desirable outcomes all of which cannot be jointly achieved in a context of scarce human, financial, and other resources. These problems require a continual process to address them, just as our dynamic productive harmony model requires an ongoing process of decisions regarding routine "maintenance" and adaptation to surprises (a tree falling on the roof) for sustainability. In recognition of these properties and to simplify discussion, we grouped chapters into three sections:

- Science, Technology, and Engineering (Tools and Methods)[12]
- Politics and Policy (Governance and Frameworks)
- People and Action (Stewardship, Community, and Implementation)

The order of these sections mirrors in a way the chronology of approaches to land restoration.

Scientific management was introduced at the turn of the nineteenth to twentieth century and "decisions based on sound science" has been the mantra for natural resource management agencies ever since (McKinney and Harmon 2004; Karl et al. 2007). Engineering solutions started modestly with control of flooding, for example, by constructing dams and levees and draining wetlands and marshlands to turn them into "productive" lands. As technology advanced, engineering solutions became more ambitious; the construction of the enormous dams in the western

[11] Although it appears late in this book, Chap. 20, *The Tomales Bay Watershed Council: A Model for Collective Action*, is especially important as an exemplar of this new ethos in action.

[12] "Our job is to harmonize the increasing kit of scientific tools and the increasing recklessness in using them with the shrinking biotas to which they are applied. In the nature of things we are mediators and moderators, and unless we can help rewrite the objectives of science we are predestined to failure."— Aldo Leopold (1949)

Sections III and IV address our role as mediators and moderators and stewards of the land.

states and the attempt to manage water in the Greater Everglades Ecosystem for agricultural purposes are examples. Whereas some of these projects have provided great benefits, they have also often transformed ecosystems in ways that have resulted in unintended negative outcomes. The devastation of New Orleans by Hurricane Katrina is one example, which many attribute to man and not nature (Groat 2005; Thornburgh 2005). Nature repeatedly has taught us many lessons, but we do not learn those lessons well. Without doubt, science, engineering, and technology have produced innumerable benefits to humankind. However, with respect to engineering large ecological systems we have come up short. Leopold (Meine 1988, 383) hit the nail on the head:

> 'What I decry is not so much the prevalence of public error in the use of engineering tools as the scarcity of engineering criticism of such misuse.' The engineer respects mechanical wisdom, … because he creates it; *he lacks respect for ecological wisdom not because he is contemptuous of it, but because he is unaware of it* [emphasis added]. 'We end,' Leopold concluded, 'at what might be called the paradox of the twentieth century: our tools are better than we are, and grow better and faster than we do. They suffice to crack the atom, to command the tides. But they do not suffice for the oldest task in human history: to live on a piece of land without spoiling it.'

Our use of the word science includes the social and political sciences as well as the natural and physical sciences. The dynamics and complexity of coupled natural and human systems require an *integrated,* interdisciplinary approach. And local, experiential, and indigenous knowledge need to be part of the equation for describing and understanding these systems. Scientists often dismiss this form of knowledge. But as Thoreau states in *Walden* (Sayre 1985, 490):

> Fisherman, hunters, woodchoppers, and others, spending their lives in the fields and woods, in a peculiar sense a part of Nature themselves, are often a more favorable mood for observing her, in the intervals of their pursuits than philosophers or poets even, who approach her with expectation. She is not afraid to exhibit herself to them. … We are most interested when science reports what those men already know practically or instinctively, for that alone is a true *humanity* [emphasis original], or account of human experience.

Thoreau, in 1854, appears to have answered the question that E.O. Wilson posed in 1998 (13) and believes every college student should be able to answer: *"What is the relation between science and the humanities, and how is it important for human welfare?"*[13]

We need to heed voices of the past such as Thoreau and Leopold, while continuing to make new discoveries. *Ultimately, however, it is through social and deliberative processes that individuals singly and in communities articulate their values and priorities, identify challenges to fulfilling those values and priorities, and determine*

[13]Theodore Roosevelt also pondered this question. "His subject, 'Biological Analogies in History,' was one that he had pondered since discovering, as a teen ager, that he was equally drawn to science and the humanities. It seemed to him that these disciplines, rigorously separated in the nineteenth century might drawer closer again in the twentieth, as scientists looked for narrative explanations of the mysteries of nature, and scholars became more abstract and empirical in their weighing of evidence (Morris 2010, 74).

how to address those challenges. Scientific and technical tools should be aids to a deliberative process and not an intrinsic end.

Political systems refer to institutions and rules by which communities, regions, and nations conduct their collective decisions and allocate shared resources. Politics arise as participants jockey for voices in shaping these institutions and rules. Because many natural resources are public and land and natural resource decisions—public and private—affect communities, these decisions are buffeted by political jockeying. There is constant conflict between the western and eastern states at the federal level over resource issues. Communities compete for water. Resource users compete over who has access to what resources, when, where, and how. Different federal agencies have mandates to manage the same resources. The Bureau of Reclamation has jurisdiction over many hydropower and irrigation projects; the Army Corps of Engineers constructs and manages navigation and flood control projects. The Bureau of Land Management (Department of the Interior) and U.S. Forest Service (Department of Agriculture) both manage public lands, often with conflicting regulations pertaining to logging, grazing, recreation, and other land uses. There is little coordination among agencies, and often competition for limited financial resources. Here again, Leopold (1949, 213) was prescient: "At what point will governmental conservation, like the mastodon, become handicapped by its own dimensions?" In response to the unimaginable environmental crises of the 1960s—polluted waters, contaminated soils, dirty air—a series of laws were enacted (NEPA, Clean Water Act, and Endangered Species Act are examples). Many of these acts are administered by different agencies with sporadic or no coordination and often rivalry.

Within this medley of agencies, sometimes overlapping laws, competing priorities, and political conflict, environmental and natural resource managers often looked to science, in rhetoric if not always in practice. Again, analogous to the initiation of scientific management to mitigate or obviate partisan politics, outcomes mandated by some of these acts were based on concepts of risk assessment (National Research Council 1996), though regulatory decisions and environmental management practices reflected a continual mix of politics and science.

The concept of adaptive management, first clearly articulated in the early 1970s (e.g. Holling 1973, 1978; Walters 1986), produced insights about resource management in a context of scientific uncertainties and dynamic conditions. Subsequently, recognizing the interconnectedness of many resource management issues, the concept of ecosystem-based management surfaced in attempts to manage natural resources and public lands more holistically. However, in more than three decades of practice only a handful of adaptive management cases worldwide have been successful, and many large-scale efforts at ecosystem-based management have met with significant implementation challenges. The reasons for this vary and involve ecological, political, and social issues. Changes in ecosystems in response to management decisions may take decades to detect; the short-term nature of the political and funding cycles is not compatible with the long-term nature of adaptive and ecosystem-based management. Consequently, funds are not appropriated to monitor and evaluate the effects of management decisions, which is a basic principle of adaptive management. Sometimes adaptive management plans have been developed without close collaboration of scientists and managers. Perhaps most fundamental is that current governance rules and structures are not well suited to use these management practices that require flexible and cross-agency decision making.

Increasingly, conventional top down governance models and policy tools for managing lands are not sufficient for dynamic, integrated solutions to our vexing and complex environmental problems (Koontz et al. 2004; Brunner et al. 2005; Ison and Collins 2008). Consequently, new governance models such as adaptive governance and networked governance are emerging. These new models emphasize cross-agency coordination, public-private collaboration, and flexible responses to ever-changing conditions. In part as a consequence of the environmental crises of the 1960s and out of frustration over what was perceived as insufficient action by the federal and state governments, citizens became more active in environmental and natural resource management issues. Many watershed associations sprang up around the country. Now there are hundreds of collaborative groups where citizens participate in managing lands with uneven success.[14]

No process or approach is a panacea. Still, well-designed collaborative processes that involve diverse participants hold great promise (Wondolleck and Yaffee 2000; Bryant 2004; National Research Council 2008). The Department of the Interior, the Nation's largest land management agency, in its fiscal year 2003–2008 strategic plan, set as a goal the creation of a nation of citizen stewards with department personnel gradually working as facilitators with citizens to manage and restore lands. In essence, it is an attempt to develop a community of practice. Once again, we go to Leopold's well (1949, 203, 204). "All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts. … The land ethic simply enlarges the boundaries of that community to include soils, waters, plants, and animals, or collectively: the land."

This book mirrors that enlarged community through the mix of chapters that are interdependent. Each section is introduced with a chapter that sets the context and links the section chapters into a coherent whole. The authors are colleagues and friends of the editors. Collectively, they represent scores of years of practice and active research. The narratives, for the most part, are not analyses of the work of others and cases. They manifest "action" research, policy-making, experiences, and practice of

[14]"It is not the critic who counts, not the man who point outs out how the strong man stumbles, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood, who strives valiantly, who errs, and comes up short again and again, because there is no effort without error or shortcoming; but who does actually strive to do the deeds; who knows the great enthusiasms; the great devotions; who spends himself in a worthy cause; who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who know neither victory or defeat." Theodore Roosevelt, Citizenship in a Republic, speech given at the Sorbonne, Paris, France, April 23, 1910.

doers on the ground. Their experiences are not filtered through the lens of analysts and interpreters. There are many academic books and articles that offer analyses of cases and critiques of the methods and processes set forth in this book. Whereas we may not necessarily agree with some of the premises, analyses, and interpretations of these authors, they are valuable as different points of view and should be read and reflected upon by anyone reading this book. Although there is a plethora of second-person interpretations and analyses of collaborative conservation, there is a dearth of first-person accounts. This book provides the unfiltered perspectives and stories of those whose work is often interpreted by others. We conclude the book with a synthesis of the barriers and challenges for restoring lands and sustainability, a road map for overcoming these barriers and a prescription for designing and implementing the new processes and institutions to tackle wicked problems to achieve sustainability, and an outlook for the future.

It may come as a surprise that we have so prominently cited a few voices from the past. However, in these and other classic and timeless works, there are insights that are the keys to living in harmony with nature. In our view, it is those who have lived with nature and whose livelihoods and wellbeing are bound to nature that are best able to discern and unravel how humans can live in harmony with nature. Yet, we do not marginalize the discoveries of science that provide us with information. Neither science nor local, experiential, and indigenous knowledge alone is sufficient for understanding complex and interdependent natural and human systems (Adler and Birkhoff 2002). It is through the social and political processes that these two forms of knowledge are integrated with community values. Through collaborative learning we might attain the wisdom to make better choices.

Before continuing, it is essential to define collaboration—what people acting together means to us—so that you, the reader, and we are talking the same language. There is a continuum of public participatory practices.[15] In this book we focus on the use of consensus-based decision-making processes by local groups comprised of diverse stakeholders, what is usually called multi-party negotiation (Susskind et al. 1999). Chapter 20 describes this in practice. These groups could be pieces of a larger networked collaboration. A consensus-based process sets out not to achieve compromise among the parties, but to *create value for mutual gains* (Susskind and Field 1996). This is an important distinction. There are times it is not possible to add value and the group settles for compromise. Collaborative groups arise for a number of reasons—sometimes because of the threat of litigation and sometimes organically because participants hold shared values or shared concerns. It is the grass roots, organically emergent collaborative efforts that especially interest us here.

Partnerships and coordination among parties are forms of collaboration but they ought not to be confused with a well-designed, consensus-seeking participatory collaborative process, which is guided by specific protocols and best practices. The

[15]To learn more visit the International Association for Public Participation website http://www.iap2.org/

elements of a consensus-seeking process include: inclusiveness, self-selection of diverse participants that represent a range of interests addressing a problem in common, openness, and transparency. A neutral professional facilitator usually, though not always, manages the process. The facilitator establishes ground rules with the participants. It is an ongoing and evolving process that requires numerous regular meetings. And it is not a process appropriate for all situations. A well-designed consensus seeking process will begin with an issue or stakeholder assessment (Susskind et al. 1999). This assessment will determine if a consensus process is possible, if another form of collaboration is appropriate, or if no collaborative process is appropriate. It is worth noting that critics of collaborative processes often cite power disparities as a major factor that prevents a "fair" outcome. A stakeholder assessment will determine if power differences are so disproportionate that it will not be possible to engage in a consensus-seeking process. There will always be differences in power among parties and methods have been developed to deal with these differences as part of a multi-party negotiation.[16] Like any human endeavor, collaborative process approaches do fail. There are a number of possible reasons for failure. Foremost among them, in our view, is that the process was not designed well from the beginning. When evaluating collaborative process approaches care must be taken to determine if the process is in accord with the best practices developed over the last 35 years.

In the concluding chapter we describe a form of collaboration called "collective impact initiatives"(Kania and Kramer 2011), which holds great promise for the social and decision making transformations necessary to live in harmony with nature. These "are long-term commitments by a group of important actors from different sectors to a common agenda for solving a specific social problem. Their actions are supported by a shared measurement system, mutually reinforcing activities, and ongoing communication, and are staffed by an independent backbone organization" (39).

Achieving sustainability is simple, if we have the *will* to put in place and live according to a few fundamental principles, the *willingness* to take part in a dialogue and not a diatribe,[17] to do the hard work, and the supporting institutional and decision making frameworks that provide incentives, feedback, and accountability. Most

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[16]The U.S. Geological Survey developed a role-play simulation game, called the Airport Game, in 2000 as part of a class at Stanford University on integrated approaches to environmental assessments. The roles purposefully were given disproportionate amounts of money to set up a large power disparity. The role players were allowed to negotiate outside of the classroom. We found that many of the players came up with solutions that created value. For example, two or more of the environmental groups that were not well funded, formed a partnership to pool their funds. Because of the nature of the environmental controversy (the proposed expansion of San Francisco airport into the bay), these environmental groups were in disagreement with one another. Yet, by negotiating they reached a consensus on how to proceed. The game designers developed it to be played in two 90 min classes separated by a day so that the players could negotiate outside of class if they chose to do so. The game was so successful as a learning and research tool that the Stanford Law School expanded it for use in an advanced class on negotiation.

[17]See Karl et al. (2007) and William Isaascs (1999), Dialogue and the art of thinking together: Currency (New York, London, Toronto, Sydney, Auckland), 428 p.

of all we must not be afraid to imagine what could be. Although the chapters in this book are diverse, as you read them keep in mind what we stated at the beginning of this introduction: The common thread through each of the chapters is the belief in the effectiveness of *people acting together—people having a conversation—* to achieve durable solutions for restoring lands.

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Part II
Science, Technology, and Engineering (Tools and Methods)

Chapter 2
Introduction: Science, Technology, and Engineering (Tools and Methods)

Michael Flaxman and Juan Carlos Vargas-Moreno

This section features a set of studies in which the role scientific information in complex decision-making is reconsidered in the light of new concepts, methods and technologies. The section includes a range of perspectives, starting with case studies illustrating different approaches and ending with two chapters focuses more on institutional and science management concerns.

The authors come from several different disciplinary backgrounds. But considering the topics addressed and methods used, one would be somewhat hard pressed to guess who was trained in which. The chapters include planners and architects leading projects using large simulation models in projects involving dozens of scientists, and authors trained as engineers conducting research into human preferences and institutional structures. Despite the obvious challenges, I find this to be an optimistic development – dedicated people addressing real world problems have not simply stuck to their disciplinary training and framed all problems to match their professional tools. Instead, you will find here a variety of innovative attempts to develop methods appropriate to the scales and communities where this work occurs.

As later sections will discuss, few people are actually trained to work on wicked social problems, and we cannot wait for formal new disciplines to evolve before commencing the critical work. At the same time, since we are in many cases working outside of our professional comfort zone, it is important to transfer knowledge and methods rapidly from conventional disciplines into these efforts and vice versa. To take one example, none of the investigators working on the climate change research discussed here has formal academic training in climatology. Nonetheless,

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our society needs to figure out ways to plan for climate change which don't require every institution in the country to obtain that expertise as full time staff. To consider the opposite, there is a body of knowledge in the social sciences about how group deliberative and participatory processes differ from the waterfall models of knowledge-action that remain the dominant paradigm in science and engineering circles. If we want to see more effective and rapid incorporation of science into planning and policy-making, this book provides some substantial guidance as well as pointers to some of that literature.

As the latter two papers of this section discuss, people working in these areas face a complex set of institutional constraints which very much limit their activities. Academics risk many sanctions within a system still largely governed by disciplines. Public officials face significant political and career risks. Those working in the private sector face significant financial risks, since planning "with the public" instead of "for the public" cuts to the heart of a tradition of professionalism as black-box expertise. While on the one hand we are tasked with some difficult substantive work at the level of projects and activities, we also face the need to reform the systems within which many of us work so as to create the conditions to expand such efforts to the scales needed to address actual social and environmental challenges.

It is perhaps not coincidental that most of these projects consider either water resources management, biodiversity conservation, climate change planning or some mix of the three. Water resources and species conservation issues have a long history of confounding simplistic management schemes. They are now joined and often compounded by climate change. These are the pre-eminent "wicked" problems of our generation, and have become proving grounds for innovation at a variety of scales.

All three domains involve unintended adverse consequences of human decisions on nourishment, shelter and mobility. These choices are relatively innocuous at individual and small institutional levels, but scale poorly or impose impacts on others or on other systems which are very difficult to account for. A farmer irrigating a field, someone building a house or an individual driving to a meeting – all are going about daily life largely oblivious of the broader consequences on ground water, species habitat or global climate. This is also often true even at the slightly broader scales at which these activities are managed or regulated. The water district, the county, or the Federal regulatory body don't generally have comprehensive systemic performance data in front of them when making decisions. They tend to operate incrementally, limited by jurisdiction or agency scope from even considering cumulative impacts or issues outside of their sector. Not surprisingly, this leads to conventional choices which attempt to optimize or at least satisfice direct constituents within a particular sector or jurisdiction. Absent strong social or institutional requirements to account for systemic impacts, natural systems often suffer a "death from a thousand cuts."

In the types of planning situations involving these three domains, it is impossible to remove consideration of human behavior from the equation – how human beings have behaved and will behave is integral to any sensible discussion. They are very public issues, but also ones which require explicit methods for dealing with complex simulation modeling and with expressing scientific uncertainty. The lack of "standard methods" in addressing these challenges provides a natural experiment. Our authors have taken a variety of creative approaches to the complex set of social and technical issues.

Two new technologies and related ideas have started to change these kinds of circumstances. The first is the advent of near-ubiquitous "information and communications technologies" or ICT, including the cell phone and the internet. These have only been common and cheap for a few years, and the full ripple effects of these have yet to play out. However it is already very clear that they are flattening traditional hierarchies by providing widespread access to both more and better data about the world around us. These data include empirical information about the world around us, such as Google Earth and related technologies. But they also include the ability to instantly transmit feedback about human decisions. A brief example may help illustrate. This author was traveling in Hanoi, Vietnam the day that Google Earth was released, and was sent an email to that effect. Sitting at an internet cafe, he opened the program and browsed several locations. This prompted immediate interest from neighbors in the cafe, who immediately downloaded the program and began looking for their houses and neighborhoods. A week later, every machine in that cafe had a copy of the program and hundreds of people had spontaneously used it and showed their friends. The rapidity of this particular program's adoption surprised everyone at the time, but has now become a common phenomenon. In 1 year, Google Earth attracted more than 100 million users and is now reported to have surpassed 600 million unique installs. To put this in context, geographic information systems (GIS) technology which had been the only prior tool allowing access to this kind of information took 30 years to achieve its first one million users.

Software that is distributed over the internet or over phone networks has the important characteristic of combining static data, a program, and a user community. The idea that users can contribute valuable content is commonly known as "web 2.0." Creating programs which can propagate through and develop social networks has become the second wave of ICT, and this will have effects on planning and management at least as important as the provision of static information. Most current science and management techniques are based on their idea of scientists or government authorities gathering their data for a specific purpose, then analyzing it, then formally publishing their analyses – but not the underlying data. This model will probably continue to occur for some time. But layered on top of it today is a veritable tsunami of "volunteered information" much of it containing geographic components. This is already much larger than the universe of officially and intentionally collected information, and is growing at a much higher rate. Therefore, the next years are likely to see a very large increase in systems and methods which are able to harvest and repurpose messy information collected for other purposes, or the use of volunteered information in new contexts. Some early examples include a variety of citizen science and citizen activism projects in which the locations of treasured scarce resources or social and environmental problems are tracked by individual volunteers. Cell phones with GPS and cameras allow many people to contribute observations over large areas. An example of this was the recent Gulf oil spill, in which thousands of GPS'd pictures of wildlife and beaches being affected by oil were amalgamated into a real-time response map.

The second major component of ICT which is having profound consequences on planning is the widespread use of simulation technologies. While simulation models have existed for years "in the lab," they have historically been design by scientists and engineers largely for themselves. What is new is the connection of such models to visual interfaces which can be understood by much broader audiences, and their release "into the wild" in the form of decision support tools for managers, or web services for general public use. Many of the projects in this chapter are examples of attempts to use these new capabilities to build public understanding, or to mediate discussions about management options. This is a more profound transition than many people realize since participation in the activity of modeling has two non-trivial consequences. First, it is deeply engaging. A variety of studies have shown that people pay more attention to information when it is embedded in interactive forms than when presented statically. Second, it can involve very important aspects of learning, particularly social learning across traditional disciplines and social barriers.

The first two chapters outline the recent research work of this author and colleagues, which update stakeholder-based scenario planning methods to leverage new information technologies. Both chapters draw from the same case – climate change adaptation planning for conservation in South central Florida. The first chapter, by Vargas-Moreno, focuses on the use of participatory spatial simulation as a method for tractably managing the propagation of uncertainties inherent in long-range planning. The second chapter, by Flaxman, considers the methodological challenge of developing planning recommendations despite the uncertainties and differences of opinion made explicit in scenario planning.

The Florida studies considered a large region, and worked with a stakeholder group composed largely of managers and professionals working for Federal, state and local governments. By contrast, in Chap. 3, Kirshen and colleagues describe work addressing similar climate change adaptation issues, but in a completely different social context. This group worked at neighborhood scale with residents of a disadvantaged community. The methods used were almost completely different. In many ways, this was completely appropriate, since the decisions to be made by the two groups were also vastly dissimilar. In the first case, those participating were representatives of institutions and agencies actively responsible for managing billions of dollars of public assets and for rule making across large areas. In the second case, the group participating were mostly local resident renters acting individually, most lacking full control even of the structures they inhabited.

If even modest future climate change projections come to bear, both of these groups will need to take adaptation actions. In both cases, we might like to see their actions informed by appropriate science, technology and engineering. One can even imagine them drawing on a common scientific base, for example in providing accurate estimates of sea level rise and storm surges. But it is hard to imagine a single set of planning and deliberative methods being appropriate across this range of scales and audiences. This sets up one of the recurring themes of this section, which is that while science may strive for universal truths, science-informed management must inherently address application domains that can vary more widely than their process descriptions might indicate. Both Vargas-Moreno and Kirshen characterize their approaches as participatory and stakeholder-based, but it is perhaps part of the nature of such processes that they are targeted and responsive to the audiences they seek to serve and the scales at which they seek to intervene.

This issue is perhaps implicit in the guidance of the National Research Council to “(1) begin with users’ needs” (NRC 2009). However, the characterization of appropriate user groups remains as much an art as a science, and there is also little guidance available on appropriate spatial scales of intervention. One method does not fit all, but it is also clearly infeasible to generate unique processes for every imaginable group and scale. How do we decide? We will be on shaky ground until we have better empirical information on how user groups’ values and decision-making processes vary.

The work of Barreteau (Chap. 6) deepens this discussion by inviting us to consider not only the role of models as “boundary objects” but even more broadly the role of “modeling” as a boundary institution. If simulation is as important to the future of planning and management as our authors indicate, then the strong implication is that new types of social institutions will be needed. The infrastructure required to support modeling as a purely technical activity conducted exclusively by scientists and engineers is almost completely different from that needed to broadly support citizen engagement in participatory modeling.

In the final chapter in this section, Matso brings this issue strongly into focus, coming from the perspective of someone responsible for managing the funding of collaborative science research. The process by which such science is reviewed and funded is critical to the ultimate success of such efforts. Matso’s work sheds considerable light on just how tricky such processes can be to set up, and certainly why they remain the exception rather than the rule.

Chapter 3
Using Participatory Scenario Simulation to Plan for Conservation Under Climate Change in the Greater Everglades Landscape

Juan Carlos Vargas-Moreno and Michael Flaxman

Abstract Because changing climate is expected to shift the distribution of suitable areas for many species, it poses a substantial challenge to conventional conservation planning approaches which rely on the establishment of fixed protected areas. Over the next decades, climate change will also cause changes in human settlement patterns and on demands for various ecosystem services. New conservation methods are needed to deal with these complex phenomena. We believe that participatory spatial simulation approaches have much to offer under such circumstances, since they address both institutional and technical planning needs. From an institutional point of view, such exercises engage relevant stakeholders across various agencies and administrative jurisdictions. From a technical point of view, the simulations performed provide actionable information, since they help to prioritize potential conservation actions and generate landscape-scale strategies. This chapter presents a case study applying such an approach to the challenges of conservation planning for the Greater Florida Everglades.

Keywords Climate change adaptation planning • Scenario planning • Participatory modeling • Alternative futures • GIS

1 Introduction

There is widespread recognition that climate change will fundamentally affect how conservation planning can and should be done. As Hansen et al. (2010) state: "to be successful, conservation practitioners and resource managers must fully integrate

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the effects of climate change into all planning projects." This is a tall challenge, since accounting for climate change adds enormous complexity to what is already a difficult process.

Recent work in conservation planning has concentrated on how shifting habitats and species populations may affect biodiversity conservation (Parmesan and Yohe 2003; Parmesan 2006). However, it is equally important to recognize that ecological stressors are now themselves being altered by climate change. First, there is reason to believe that human populations will adapt and shift in response to climate change (Perch-Nielsen et al. 2008). Those responses potentially affect not only settlement patterns, but also many other sectors and land uses impacting conservation, including fisheries, agriculture and forestry. Second, as supplies of natural resources such as water become less reliable, ecological systems will likely face additional competition from human consumptive uses (Diamond 2005). Third – and more positively – human choices and policies for climate change mitigation provide an opportunity to alter economic, transportation and land use decisions in ways which might better support conservation initiatives.

Such impacts are technically second order effects of climate change, and are thus subject to significant uncertainties. This has led some to adopt a "wait and see" position, attempting to defer such analyses until climate change science is more definitive. We believe that this is a fundamental strategic mistake. Conservation planning is a social process, not simply a matter of technical analysis. New issues and information must be deliberated within a number of public and private decision-making processes before actions can be initiated. The key challenge of conservation planning under climate change is not to come up with a single decision based on new information or analysis. The challenge is to develop planning methods and decision-making structures which are able to routinely incorporate uncertainty, changes in science and conflicting human values. While climate science is improving rapidly, human adaptation and political decision-making is integral and will remain inherently unpredictable. Therefore, we must develop and test planning methods now which are capable of routinely incorporating new information and which are robust when faced with scientific and political uncertainty.

2 Background

The evidence for global warming is unequivocal and rising concentrations of Greenhouse Gases (GHG) are already affecting world climate. While many factors continue to influence climate, scientists have determined that human activities have become a dominant force, and are responsible for most of the warming observed over the past 50 years. Human-caused climate change has resulted primarily from changes in the amounts of greenhouse gases in the atmosphere, as well as from changes in land use (Le Treut et al. 2007). The Intergovernmental Panel on Climate Change (IPPC) draws several stabilization paths and points out that carbon dioxide equivalent gas levels in the atmosphere should not exceed 445–490 ppmv (parts per million by volume). This is the most benign trajectory, in which the effects of climate change are minimal but the required emissions reduction is highest. This implies that by the year 2050, GHG emissions should be reduced between 50% and 85% in comparison with the year 2000 (NRDC 2008).

Climate changes possess many complex challenges on society and the management and planning of landscapes. Climate change is expected to have major impacts on ecological, social, economic and political aspects of human society (Dale 1997). Different studies show evidence of threats in areas such as agriculture and food security (Parry et al. 1999; Reilly et al. 2003), public health (McMichael et al. 2006), real estate pricing, insurance and taxation (Tucker 1997), human settlement patterns (Smith et al. 2000), and sustainability and equity (Smith 1997).

For conservation planning and management, climate change represents a significant threat as the reported and projected changes may cause a variety of problems ranging from habitat changes (Araujo et al. 2004; Cramer et al. 2001) to arrival of so-called refugee species (Benning et al. 2002). These impacts not only pose operational challenges in the management of existing conservation areas – they may require fundamental reconfiguration of entire conservation networks. Current laws, policies, reserve structures and selection methods may all need to be revised to ensure species' long-term persistence.

Recognizing these threats, the US Fish and Wildlife Service (FWS) and the US Geological Survey (USGS) requested an investigation of the possible challenges posed by climate change and landscape urbanization to the Greater Everglades Landscape. The study was conducted by our research group within the Department of Urban Studies and Planning of the Massachusetts Institute of Technology. The objective of the research initiative was to develop a participatory spatial simulation modeling approach which would allow managers and other regional stakeholders to understand the first and second order effects of climate change and landscape urbanization. The 2 year study was designed to support collaborative exploration of these issues between scientists and managers (Beierle and Konisky 2001).

2.1 Spatial Participatory Scenario-Planning

Public participation has been an essential component of ecological planning for many decades. The basic goal of applying participatory process is to increase transparency and accountability in decision making (Ashford and Rest 1999). Participation is critical to ensure that all relevant information and knowledge is included, that it is synthesized in a way that addresses parties' concerns, and that those who may be affected by a decision are sufficiently well informed and involved to participate meaningfully in the decision (NRC 1996).

Spatial forms of participation are increasingly used in complex societal and environmental planning problems (Obermeyer 1998). In participatory spatial planning, a set of representative stakeholders are involved in a collaborative decision-making process that is organized around spatial analyses, and makes extensive use of maps or spatial diagrams. This technique is best suited to situations in which there are significant geographic variations in the distribution of people, resources, or management choices. This is obviously the case for climate change in coastal areas, since in these cases sea level rise is an important and non-randomly-distributed impact.

Spatial planning can also be useful in a wide variety of other cases, thanks to the relatively unique communicative power of maps. Maps are a form of data visualization which can be useful to both technical specialists and to lay people. For this reason, when spatial information is used as the main channel of communication and consensus building, the process can be made open and equal to parties with a range of technical and professional abilities and experience. For example, rather than to directly present a multi-level statistical model, the results from such a model can be spatially plotted across the landscape familiar to the stakeholders involved. The use of this medium does not guarantee anything about the validity or appropriateness of the model use, but it does This allows participants familiar with the geography to understand the outputs of a system or model without needing to understand technical details. While participatory planning without simulation modeling is still common, progressively more sophisticated models are being integrated into planning practice using Geographic Information Systems (GIS) (Rambaldi et al. 2006; Vargas-Moreno 2008) or web interfaces (Flaxman and Li 2009). The combination of spatial participatory methods with simulation is relatively complex, but the complexity is merited when goals include not only scientific advancement, but also social and institutional learning.

Two fundamental issues which come up in most non-trivial applications of participatory planning and simulation are what to do in cases of uncertainty or of disagreement. Many conventional approaches ignore these issues, typically by proceeding with a mean value and perhaps an "error" term. A more inclusive and careful approach is to explicitly model the consequences of disagreements or uncertainties, an approach generically known as "scenario planning." Traditionally, scenarios have functioned not only as contingency-planning methods, but also as learning tools for organizations wanting to explore future change and deal with uncertainty (Schoemaker 1995). Scenarios are employed in a variety of fields and are particularly prevalent in strategic planning for business. By capturing examples and illustrations, scenarios help people in reasoning about complex systems (Potts et al. 2002).

In scenario planning, the identification of key uncertainties is an objective of the method, and not treated merely as inconvenience or error. Different plausible futures are modeled, based on different sets of assumptions about key variables (Steinitz et al. 2005). This allows the construction of multiple stories that encompass a variety of potential futures (Chermack 2004). Schoemaker (1995) suggests that scenario planning is appropriate when a planning process is considering long time frames and where significant change is likely, but the outcomes are not obvious, and where stakeholders have conflicting and heterogeneous interests and values. Schoemaker further suggests that scenarios can also create unexpected benefit when they are used strategically, by stimulating participants to think about the so-called third area of knowledge, or "things we don't know we don't know."

We believe that spatial and participatory scenario planning methods are well suited to the challenge of long term conservation planning under climate change. They can collectively establish legitimacy (Smith 1973) despite irreducible uncertainties and differences of opinion. They provide a means of applying best-available science to a set of issues which necessarily involve high degrees of spatial variation. The spatially-explicit "alternative futures" maps developed in such processes are both tangible and computable. The first characteristic is important in terms of public understanding, and the second for both strategic planning and scientific analyses.

2.2 The Study Region

The Everglades is an interlinked chain of natural and human ecosystems comprising more than one and a half million acres of natural landscape – or roughly 10,800 square miles spanning the southern section of Florida (Davis et al. 1994).

The Greater Everglades Landscape is one of the most vulnerable regions to climate change in the U.S. Its low elevation makes it very susceptible to sea level rise and its fragile ecosystems are sensitive to changes in temperature and hydro-regimes. Some of the potential risks include population displacement, loss of economic assets, critical infrastructure failure, and an increased occurrence or severity of natural disturbances such as hurricanes and droughts. In addition to the threats posed by climate change, the population of the Greater Everglades thirty-county landscape is expected to increase by 13.5 million inhabitants over the next 50 years, requiring as much as 1.7 million acres for urban land use. This demand will create unprecedented landscape changes that will produce significant challenges to ecological systems and human populations. In particular, these forces pose a unique challenge to conservation management and planning in the region. Given the region's complex socioeconomic and ecological dynamics and the large number of governing agencies involved in conservation planning, a key research objective was to create a set of exploratory scenarios useful for decision-making across current conservation planning agencies and jurisdictions.

This landscape has been subject to profound modifications through time. It could be characterized as a region constantly transformed, engineered and regulated, in which different agencies and forces exert control in diverse ways and scales. Hurricane-related flooding in the 1920s accelerated drainage projects, culminating in the Congressionally-authorized Central and Southern Florida (C&SF) Flood Control Project in 1948, which further fragmented it (Garcia 2010). The transformation caused by the flood control interventions unleashed a process in which the natural landscape was extensively modified by agriculture, urbanization, and the engineered diversion of surface waterways. Approximately one-half of the 1.2 million hectares once covered by Everglades wetland were converted for human uses of agriculture and development (McCauley et al. 2010). This process of transformation created an irreversible environmental impact in the region. An estimated 50% of the original ecosystem has been lost since 1900, representing a conversion of 6,000 km^2 of Everglades' wetlands and pine forest, as well as the loss of three of seven physiographic landscapes in the original system (Davis et al. 1994).

In light of this, the Federal government and State of Florida are attempting to undo the environmental damage wrought by approximately 100 years of land use and land

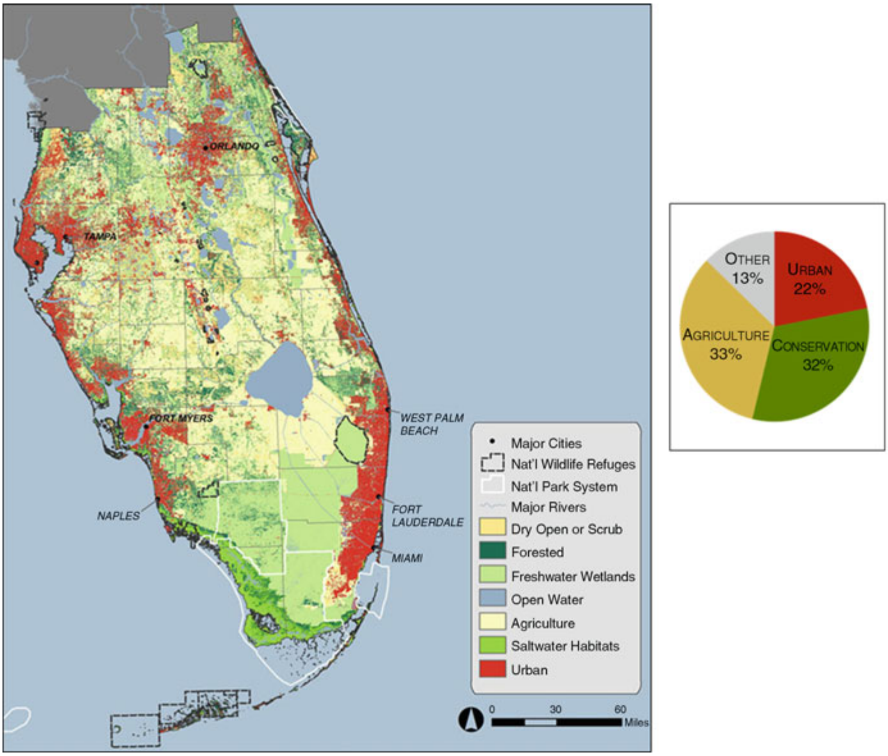


Fig. 3.1 Region of study and its land use composition

cover change that have reduced the Everglades ecosystem to approximately 50% of its 1800s extent (Walker 2001). During the past two decades, the Florida Legislature and Congress have enacted several laws and programs aimed at restoring the Greater Everglades ecosystem. In 2000, the U.S. Congress authorized the Comprehensive Everglades Restoration Plan (CERP), expected to be implemented over the next four decades. Unfortunately, these efforts did not account for the projected climate changes nor to the rate of population growth this region has experienced recently.

The geographic extent of the region of study was defined by a process conducted in conjunction with project stakeholders. It was decided that in order to account for the most relevant socio-economic and environmental dynamics as well as to consider most climate-related challenges affecting the Everglades, the study region should consider a much greater area that the protected Everglades area itself. The selected geographic extent was named the "Greater Everglades Landscape" of GEL. This area encompass 19.3 million acres (or 78,000 km^2) , has a population of 15.3 million inhabitants and features a wide range of protected areas including 23 National Wildlife Refuges, 2 National Parks, 1 National Preserve, 1 National Seashore, and 79 State Parks. The total area expands over 30 Counties from north of Orlando to the Florida Keys. See Fig. 3.1.

3 Methods

3.1 Participatory Scenario Development

We used an in-depth participatory spatial simulation modeling approach. Under this approach, a representative stakeholder group is assembled which includes those ultimately responsible for implementing or executing decisions. This group then works with the research team to scope issues of concern, and generate a set of scenarios and indicators. The scenarios incorporated the widest range of plausible conditions within which conservation plans should be evaluated against. The indicators are qualitative or quantitative scales which can be used to monitor the success or failure of plans along particular dimensions.

First, an initial group of stakeholders was convened based on the US Fish and Wildlife Services (FWS) "ecoteam." This is a group of FWS managers with the responsibility of managing Federal Wildlife Refuges and Endangered Species in the Southern Florida region. In a series of workshops, these managers were asked to review and comment on the scientific literature describing actual and potential effects of climate change on the region. Next, a set of cognitive mapping exercises was conducted with the initial group in order to identify key resources and relationships as well as potential additional stakeholders (Barreteau et al. 2010). Using a "snowball" strategy, an expanded stakeholder group was then constituted, consisting of approximately 50 professionals from across different sectors and with responsibilities across the region.

Once an appropriate stakeholder group was assembled, the major assumptions and impacts of potential concern were scoped and bundled into prospective scenarios. Stakeholders were asked to prioritize variables for inclusion, and then to group these variables into "dimensions." The overall process of scenario development was organized by Assumption-based scenario planning process for climate change (Vargas-Moreno 2009) which is illustrated in Fig. 3.2.

Once the assumptions process was developed the stakeholders identified four top-level dimensions: climate change, human population demographics and preferences, availability of financial resources, and land and water policies (including conservation strategies). For each dimension, stakeholders developed a bounded set of parameter values or assumptions and picked a small set of measurable indicators. For example, qualitative descriptions of climate change included low, medium and high groupings, each quantitatively defined in terms of sea level rise, temperature, and precipitation based on IPCC 2007 model outputs (Solomon et al. 2007). The intent here was that qualitative descriptions remained relatively consistent through time, while their mappings to specific parameter values could be adjusted regularly based on the best available science. The land, water and conservation rules dimension was the most complex, with over 100 separate policies considered and packaged into two major grouping: "business as usual" and "proactive."

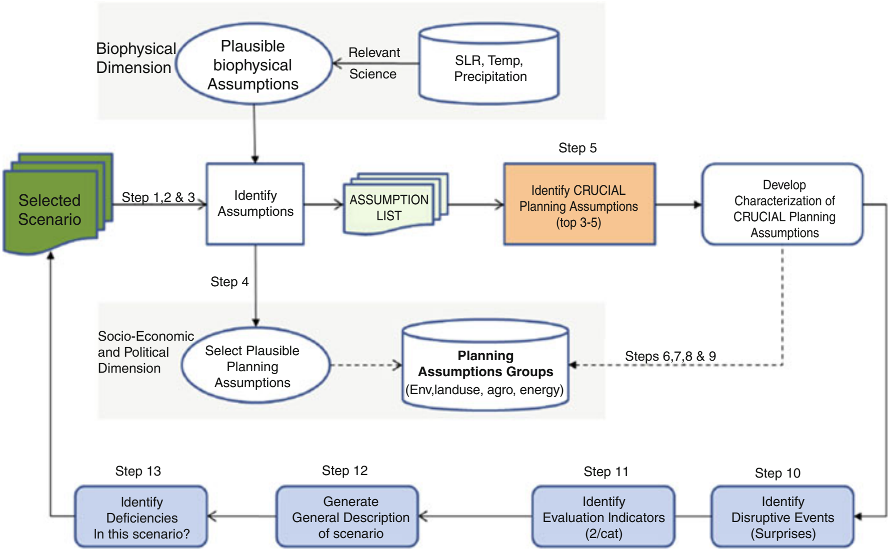


Fig. 3.2 Key steps in assumption-based scenario planning

Each scenario or bundle was created using the following steps:

- Identification of Scenario Dimensions (biophysical and socio-economic parameters to incorporate in the study as major drivers of change).
- Characterization of Local Values Ranges for Scenario Dimensions (research and data)
- Selection of Nominal and Numeric Values for Each Dimension (i.e. "low SLR = 18" by 2060)
- Bundling of "assumption packages" across dimensions
- Prioritization of scenario bundles.

Scenarios were vetted in four large face-to-face workshops over the course of a year. In the first two, scenario components were discussed in relatively abstract fashion based on literature review. In the third and forth workshops, all of the variables were represented in mapped form at scale and with specific values across the study area. For example, early workshops discussed sea level rise as a single average value across the region, while later workshops examined simulation model outputs mapping potential changes in this variable. In addition to large group workshops, we also conducted a series of several dozen individual and small group meetings. We met with the chief planner and/or climate change task-force members from most of the 30 counties in the study area. This later process made clear the value of local knowledge in constructing regional scenarios, since several variables initially considered only at regional scale were found to have enough interregional variation to warrant more detailed consideration. The final scenario input assumptions (as selected by stakeholders) are shown in Fig. 3.3.

Climate Change	Population (in millions)	Plannning Assumptions	Financial Resources
Low (+3.6″ SLR)	Trend (25)	Business as Usual (B.A.U.)	Low ($)
Medium (+18.4″ SLR)	Double (29)	Proactive	High ($$$)
High (+39.1″ SLR)			

Fig. 3.3 Scenario input assumptions and corresponding values and units

Scenario	Climate Change	Population	Planning Assumptions	Financial Resources
A	LOW	DOUBLE	Business as Usual (B.A.U.)	LOW $
B	LOW	TREND	PROACTIVE	HIGH $$$
C	HIGH	DOUBLE	B.A.U.	LOW $
E	MEDIUM	DOUBLE	B.A.U.	HIGH $$$
I	HIGH	DOUBLE	PROACTIVE	LOW $

Fig. 3.4 Priority stakeholder scenarios. *Notes*: *B.A.U.* "Business as Usual" Following current legal standards and trends

The final set of priority scenarios employed in the project and its composition is show in Fig. 3.4. Through an individual and then group consultative process the stakeholder group explored and discussed the different bundles of assumptions and their relevance for decision making. It is important to highlight that the priority scenarios were selected by the stakeholders with the explicit idea of exploring bundles of assumptions that they would be interested in seeing spatially simulated in future land use maps. Most importantly, the selected bundles of assumptions or scenarios did not reflect the personal stakeholder's values or beliefs, but rather their opinion as managers about which scenarios were most important to consider. The use of multiple scenarios allowed for considerable divergence of opinion. However in this case, the "top 5" scenarios had widespread and uniform support as a set.

As it turned out, the scenarios selected by our stakeholders included a variety of "bracketing" or boundary conditions. The two primary selection dimensions were climate change and planning assumptions. When plotted in a chart of these two dimensions, the selected scenarios cover most of the unique possible combinations. The least-often selected combination was an intermediate climate change future under a proactive planning environment (see Fig. 3.5). This particular formulation was not pre-ordained or suggested by the research team, and came from a potential set spanning 24 other alternatives.

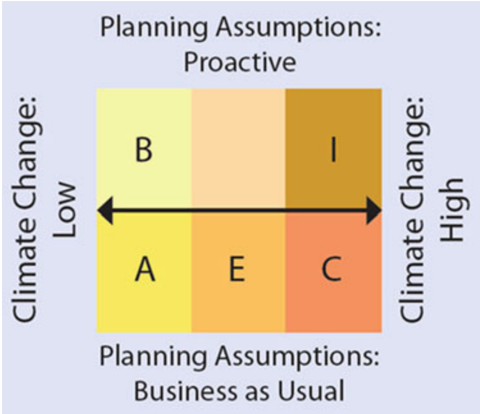


Fig. 3.5 Climate change vs. planning assumptions for the five priority scenarios

3.2 *Participatory Simulation Modeling Using the Attractiveness-Constraints Simulation Model (AttCon)*

3.2.1 Overall Process

After the initial scenario assumptions and parameters were validated with stakeholders, we constructed a spatial simulation model projecting future changes in land use for the region. The model used was a variation of the AttCon model (Flaxman and Li 2009; Flaxman and Vargas-Moreno 2011). The overall structure of this model is shown in Fig. 3.6. It requires three types of input: estimates of land use demand, spatial maps of relative development attractiveness to particular land use types, and a set of physical and legal constraints on development. The outputs of the model are projected land uses over time, in the form of raster GIS grids.

In this case, we recognized six land use types: high, middle and low-end residential housing, agriculture, ranching and conservation. These uses were generally allocated at each time horizon in the order described, an approximation of presumed "willingness to pay" in a free market. The exception was conservation, which was allocated first in the "proactive high-financial-resource" scenarios to simulate government initiated fee-simple purchase programs.

3.2.2 Attractiveness

Attractiveness to development for various submarkets was simulated using a rule-based approach. Rules and their relative weights were developed in consultation with local planners. An example of one such rule set is shown in Fig. 3.7, and the overall patterns of attractiveness across submarkets are shown in Fig. 3.8.

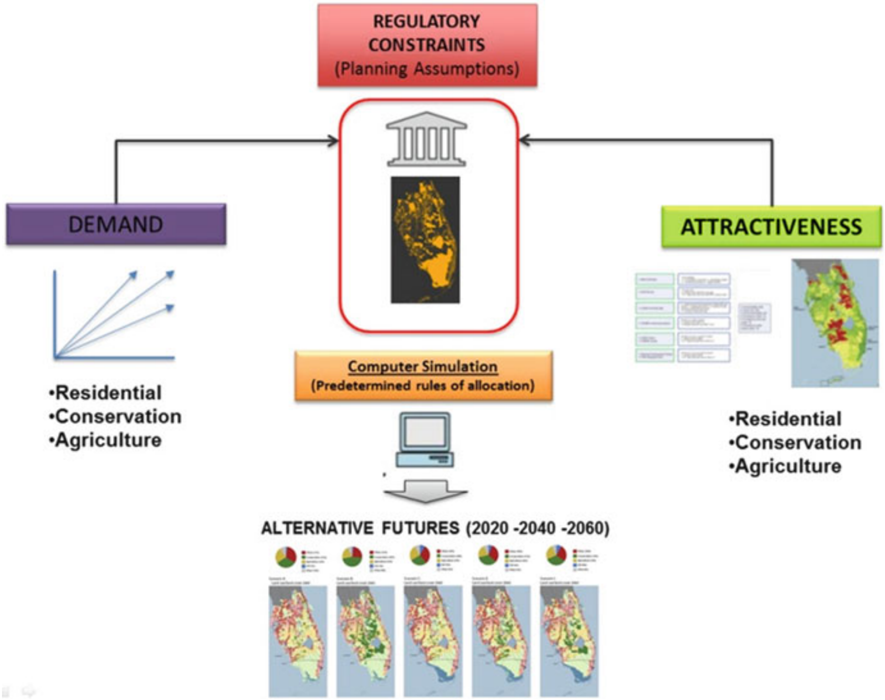


Fig. 3.6 AttCon model structure

In order to create the conservation attractiveness surface, we reached out again to the stakeholder group and held a collaborative workshop in which multiple alternative formulations were discussed. The stakeholder group was composed of federal, state and local species experts and managers. They identified three primary criteria: (1) the most valuable areas of current habitat, (2) future suitable habitat, and (3) potential connections between current and future habitat. In order to prioritize existing habitat areas, a plethora of spatial datasets and prior analyses were considered. These included: the Critical Lands and Waters Identification Project (CLIP), the Florida Ecological Greenways Network, the State Strategic Habitat database and the Florida Critical Linkages for Conservation network. The details of modeling process are described in the next section of this report. In sum, the result was a raster grid of the entire study area with a relative ranking of the conservation value of each cell ranging from 0 to 100 (see Fig. 3.8). The highest ranking cells had one of three characteristics: either they contained existing or potential critical habitat for threatened and endangered species, contained rare habitats, or they had been identified in the Greenways plan as important connecting corridors. Our ability to delineate "future habitat" was very limited, since much of the underlying science has yet to be completed. Therefore we focused on habitat areas likely to be less vulnerable to known climate changes, particularly direct loss from inundation due to sea level rise. Available species habitat models and prioritizations did not take into account climate change influences on vegetation or water regime.

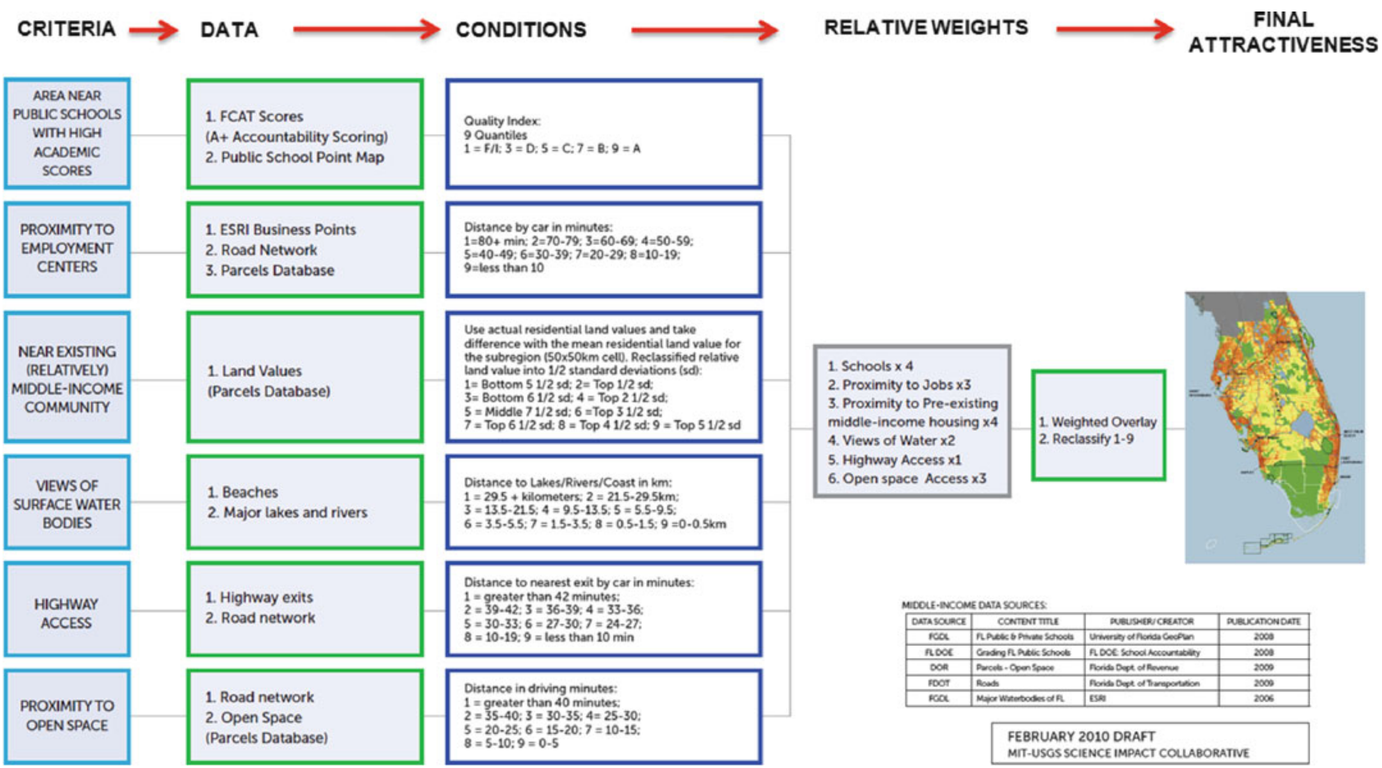


Fig. 3.7 Example rule set: attractiveness to middle class urban development

Fig. 3.8 Overall attractiveness patterns. *High-income, middle-income, lower-income, conservation and agricultural attractiveness surfaces are shown with red indicating "most attractive" and green indicating "least attractive"*

Planning Assumptions	B.A.U	Proactive	Cost
Zoning change to penalize long commutes		X	$
Reduce new growth, no irrigation		X	$
Change in agriculture subsidies		X	$
Increase in home-owner federal and state insurance subsidies for storm insurance		X	$$$
Establish state income tax		X	$
End to home-owner federal and state insurance subsidies		X	$
Discourage growth		X	$$$
Intervention			
Central Florida east-to-west connection	X		$$$
Large expansion of road network	X		$$$
LNG terminal - fossil fuel landing	X	X	$$$
Rerouting of major highway infrastructure	X	X	$$$
Coastal hardening (fortification of coast via sea walls, jetties, etc.)		X	$$$
New water conservation zones		X	$$$
CERP with adequate water storage		X	$$$
Increase Lake Okeechobee Water Storage Capacity		X	$$$
Change in well field distribution		X	$$$
Expansion of regional mass transit		X	$$$
Rules/Constraints			
Continuation of development at current densities (sprawl)	X		$$$
Relaxation of zoning ordinances	X		N/A
Likely retreat of UGBs	X		$$$

Fig. 3.9 Initial packaging of planning assumptions

3.2.3 Constraints

Each scenario had a set of development exclusions, or masks. A base set of these exclusions was shared by all scenarios. These constraints were obtained through an extensive consultative process with the stakeholders – primarily through experienced land use and county planners. These assumptions were extracted during the scenario characterization and then package in two basic sets of "regulations" and associated with different levels of "cost of implementation" or level of public resources (see Fig. 3.9). These included not building on existing roads, in

Excluded Landscape Features	Business as Usual	Proactive
Roads	✓	✓
All Water Bodies	✓	✓
Existing Conservation Areas	✓	✓
Native American Lands	✓	✓
All Developed Parcels	✓	
Most Developed Parcels, Allows Some Redevelopment		✓
Mangrove Areas		✓
Important Water and Wetland Areas from CLIP		✓

4

Fig. 3.10 Summary of constant development constraints by scenario dimension

existing conservation areas, or on water. A second set of development constraints varied based on policy assumptions.

One set of rules – "business as usual" (BAU) – considered what would be normal and legal practice under existing rules and regulations. Under this scenario dimension, most forms of existing development were considered permanent and were not redeveloped. Exceptions were made only for low-density uses, or for explicitly identified and known "transit-oriented development" zones (Fig. 3.10).

3.3 Areas Excluded or Masked from Development (Allocation) by Planning Assumptions

In the "proactive" scenarios, we kept most of the "business as usual" rules and supplemented them with more stringent protection of priority natural and agricultural areas. However the most significant change in this scenario dimension was to allow redevelopment of some parcels with existing buildings. Two forms of redevelopment were considered. The first was extended and expanded "transit-oriented" development nodes. The locations and potential densities of each of these was discussed with county planners. The second were relatively low-value and older uses. We considered the ratio of improved value to the land value, as well as the year built.

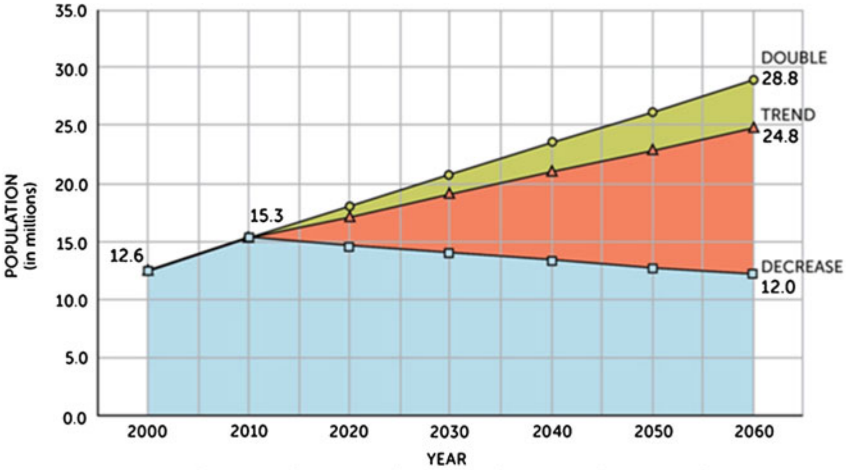
Sea level rise (SLR) was considered as a variable constraint within all of our scenarios. We used a simple "bathtub" model based on projected sea level in 2020, 2040 and 2060, terrain elevation and contiguity with the ocean. All areas under mean sea level and contiguous with ocean were considered permanently inundated. Our overall terrain surface was obtained from USGS's National Elevation Dataset. We refined this terrain by overlaying LIDAR-based bald earth terrain elevation data from NOAA and from the Everglades Depth Estimation Network (EDEN) where available.

We excluded new development from permanently inundated areas and "resettled" all current development to the next-most-attractive locations. We did this by adding inundated populations to overall demand numbers for new development based on the real estate submarket.

3.4 Demand

Demand for various types of land use was assessed based on methods which varied by land use type. For residential uses, demand was computed by multiplying an estimate of new households by an average of land use per household. The trend estimates of new households were derived from University of Florida Bureau of Business and Economic Research (2009). Florida projections per county for 2040 were linearly extrapolated beyond that date (see Fig. 3.11). Some of our stakeholders were concerned that "trend" might underestimate long term demand, in response we also developed a "population doubling" scenario, which represented a modest increase above the trend. At the same time, other stakeholders argued for scenarios in which the recent economic downturn or high climate impacts might actually reduce regional population. We also allowed this possibility, positing a 5% decrease from current population levels. Land use per capita by real estate submarket was obtained by sampling several dozen sample census blocks of relatively homogenous urban land cover for each submarket. In sampled areas, the number of households was divided by the total parcel area. The split between real estate market groups was done based on the Gini coefficients describing current income distributions.

Conservation "demand" estimates varied by scenario. We researched the history of conservation acquisitions in the area over the last 50 years and presented this information to the stakeholder group. The annual amount spent on conservation had swung wildly over that time period, from over $1 billion committed in the highest year (2006), to near-0 this year. There is no solid trend evident. Therefore, the guidance from our stakeholders was to use budget estimates which approximate one standard deviation below the median for "low" scenarios and one above for "high" scenarios. The technical details on how was conservation demands define are discussed in the following section.



	2000	2010	2020	2030	2040	2050	2060
DECREASE							
Low-Income		5.7	5.4	5.2	5.0	4.8	4.5
Middle-Income		7.9	7.6	7.1	6.8	6.5	6.1
High-Income		1.7	1.6	1.6	1.5	1.4	1.3
TOTAL	12.6	15.3	14.6	14.0	13.3	12.7	12.0
TREND							
Low-Income		5.7	6.4	7.1	7.9	8.6	9.3
Middle-Income		7.9	8.9	9.8	10.8	11.7	12.7
High-Income		1.7	1.9	2.1	2.3	2.6	2.8
TOTAL	12.6	15.3	17.2	19.1	21.0	22.9	24.8
DOUBLE							
Low-Income		5.7	6.7	7.7	8.8	9.8	10.9
Middle-Income		7.9	9.3	10.7	12.0	13.4	14.7
High-Income		1.7	2.0	2.3	2.6	2.9	3.2
TOTAL	12.6	15.3	20.7	20.7	23.3	26.1	28.8

Population projections based on Census 2000, and University of Florida Bureau of Economic and Business Research estimates 2008 - 2035 for the 30 Counties included in the Study Area. Income Distribution calculations based on GINI Coefficient trends from 1969-1999.

Fig. 3.11 Population projections and market group splits

4 Results

4.1 Overall Urban Pattern

Our simulations projected a wide range of urban land use patterns over the next 50 years, depending mostly on the population estimates and land use policies in effect. In general, allocations remained relatively faithful to existing spatial patterns, which is a reflection both of the conservative nature of the rules used to generate them and the lack of new geographic limits, transportation corridors, or ownership

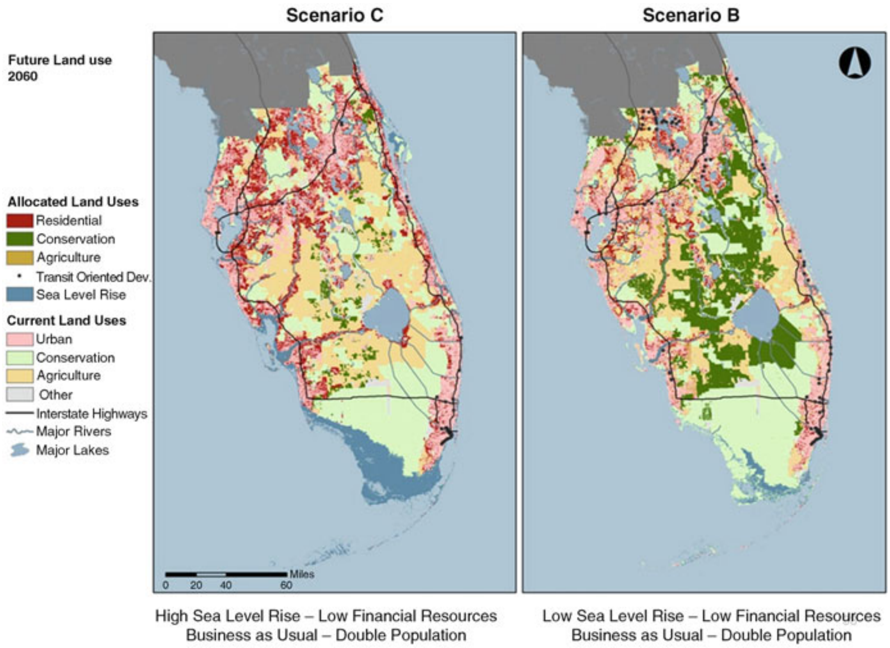


Fig. 3.12 Projected future land use 2060 under two scenarios

constraints. For example, all scenarios showed continued population growth along both coasts. The proactive scenarios with high resources were different from BAU mostly in the very strong degree of urban infill supported by new Transit-Oriented Development (TOD) locations. Such scenarios generated a very sharp decrease in greenfield residential development (Fig. 3.12).

For example, consider two of the most widely-varying scenarios. In Scenario B, there is low sea level rise (11 cm by 2060), and trend population growth. Thanks to high availability of financial resources for conservation, an aggressive set of conservation practices is put into place, supporting double the current rate of conservation acquisition. In Scenario C, there is high sea level rise (1 m by 2060) and low availability of financial resources for conservation (1/2 of historic trend conservation rate). A set of land use and water management policies similar to current are in place, and the region's population doubles.

The 2060 simulations of the five priority scenarios are illustrated in Fig. 3.13.

What are the major differences between these two scenarios? First, while the overall pattern of urban development is similar, the level of greenfield development varies significantly. Second, under Scenario C there is significant potential human displacement due to sea level rise, with 75,000 acres of developed land inundated.

Overall, the scenarios evidence substantial differences in the way the landscape is transformed over the next 50 years and reflect clear implications for conservation planning. From the drivers of change perspective, sea level rise simulations also

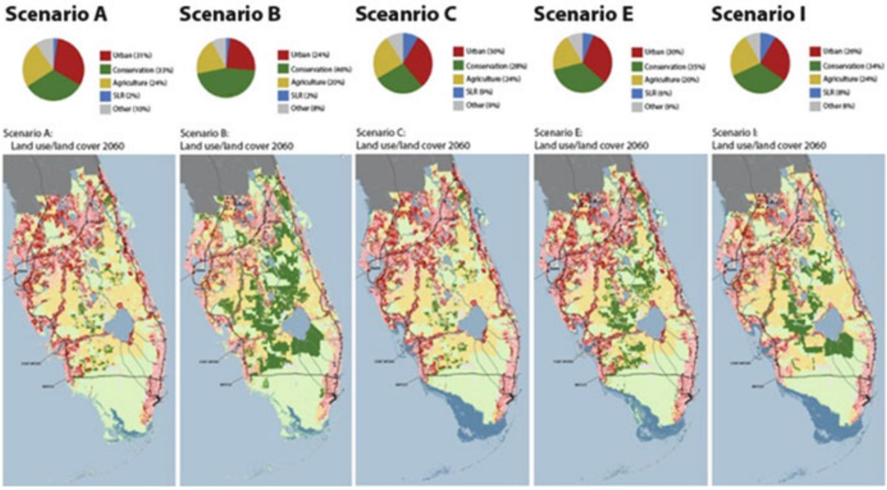


Fig. 3.13 Final set of priority scenarios (management-relevant)

demonstrated significant changes in the southern section of the region of study. Overall, the major driver of change was urban growth – basically through the development of suburban areas allocated in agriculture lands. This came as a surprise for the stakeholder which initially had thought that sea-level rise (SLR) was the most probable cause of change in the region. Contrarily, sea-level rise only accounted for a maximum of 9% of the loss of area (under the worse assumptions considered in the study). For those scenarios that only consider low SLR (scenarios A and B) SLR only accounts for 2% of land lost.

For scenarios that applied planning assumptions related to urban growth land management (primarily through the enforcement of urban growth boundaries and policies related to the densification of existing urban areas through instruments of TOD areas), urbanization accounted for 24% of the total land use composition (Fig. 3.14).

5 Conclusions

This study represents one of the more complex and comprehensive scenarios studies of its kind. It developed an in-depth participatory process involving hundreds of individuals, and well as thousands of hours of analysis and simulation work. Both the participatory and the analytical efforts were significantly more involved than prior efforts in the region, and this leads to consider two kinds of conclusions. The first are substantive and relate to the simulation approach and its outputs. The second are procedural and focus on the lessons learned in terms of the institutional processes required for effective conservation planning under climate change.

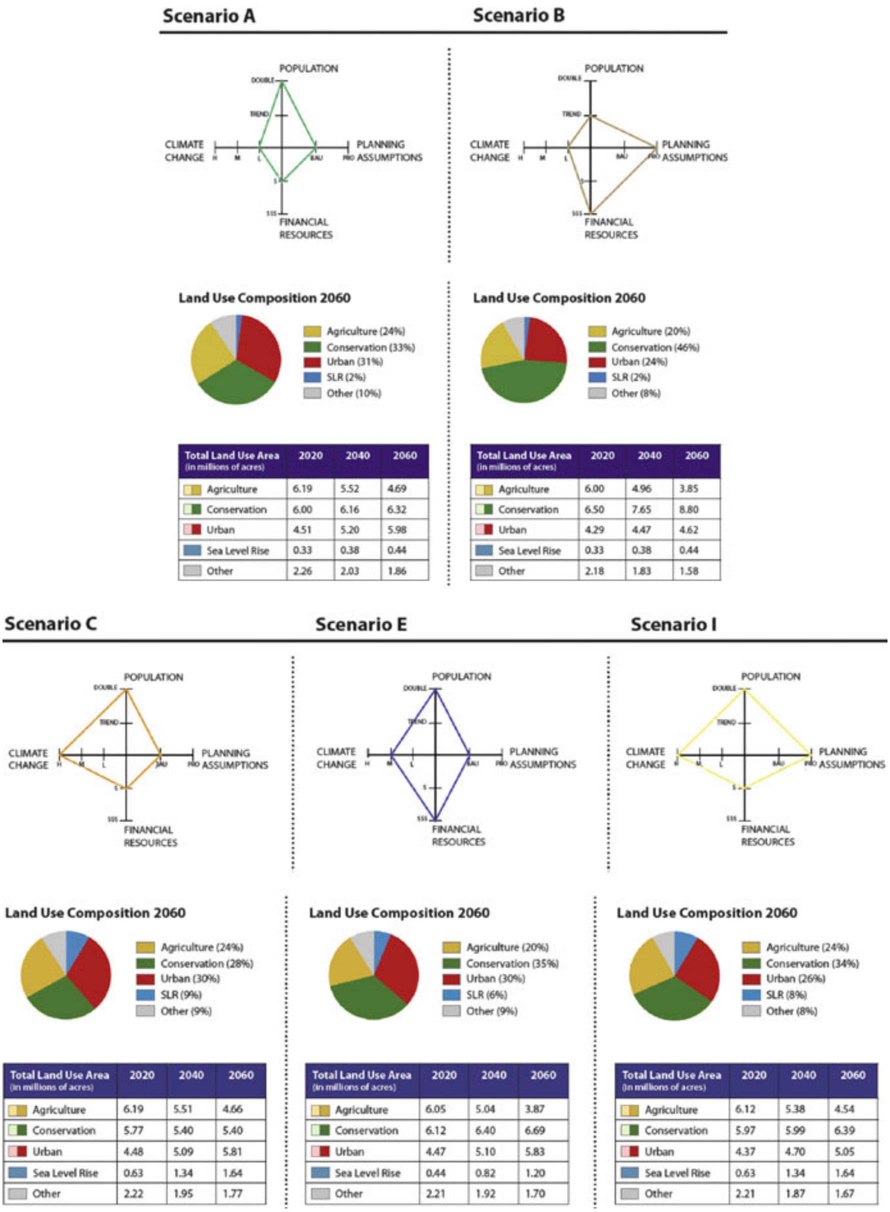


Fig. 3.14 Scenario parameters and comparison of land use changes

Scenarios	Scenario A	Scenario B	Scenario C	Scenario E	Scenario I
Change relative to 2010	%	%	%	%	%
Agriculture	0%	8%	0%	0%	5%
Conservation	7%	33%	7%	19%	20%
Urban	37%	21%	37%	36%	27%

Fig. 3.15 Percentage allocation in aggregate land area relative to 2010

5.1 Scenario Simulations

Let us first consider the modeling approach taken and its results. This is perhaps most easily comprehended in aggregate percentage area terms using the "top 5" scenarios. These selected scenarios are depicted in the table and bar chart below. From the table, we see that our urban growth modeling is relatively conservative, in that even doubling of human populations is not simulated as doubling total area. In Scenarios A & C, population doubles, but urban area increase by just under 40%. The reason for this increase is that our allocations included new land for urban development based on local zoning densities and residential service infrastructure, but did not include simulation of major new transportation projects and their set-backs. This is a fundamental limitation of land-cover based growth modeling approaches, which are the only feasible technical option when working at supra-regional scales. On the lower end of urbanization pressure and with the highest urban densities, Scenario B, shows a large difference in total greenfield urbanization: similar populations are on average accommodated in a little more than half of the space (21% vs. 37% growth). It should be noted that while optimistic in terms of adoption of transit-oriented development practices, Scenario B used planned densities confirmed by interviews with local county planners from across the region. It thus reflects and conforms to current plans, and not radical densification of the region (Figs. 3.15 and 3.16).

In terms of conservation, even wider differences in possible futures are represented. At the low end, in scenarios A and C, conservation lands increase by only 7% over 50 years. On the high end, in Scenario B, conservation increases by 33%. In Scenario E & I, approximately 20% of additional conservation land is acquired. These summary numbers are largely a consequence of a single assumption: the amount of conservation funding available. They are "realistic" in that they span the range of conservation funding which local and national taxpayers have supported in the last 50 years. However, they do not account for the potential of "unwilling sellers" or of increasing relative land prices in the future. There is some variation based on conservation strategy, which affects whether very expensive conservation lands are purchased. But overall, this variance is very small (<1%) whereas funding uncertainty is clearly a driving force. The non-spatial version of this finding is thus primarily a reflection of input assumptions and the methods used to estimate historical conservation funding. There is no single "right answer" or even median estimate of high consistency, making the use of a plausible range a good planning strategy.

The second issue of note relative to conservation findings is that of spatial patterning. Under all scenarios, the general pattern followed reflects the prior work

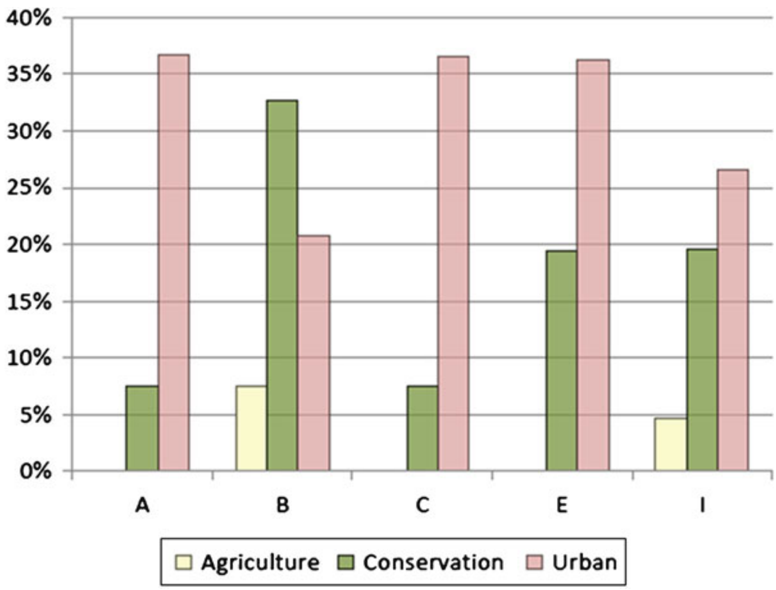


Fig. 3.16 Percentage of additional area allocated by scenario

of others, particularly the University of Florida's "CLIP" program and the state's "Florida Forever" initiative. This primarily locates conservation priorities toward the center of our study area, with a second concentration in the Saint John's watershed in the Northeast. There are two forms of important apparent differences: The first is that under low to moderate levels of funding, no cohesive and connected conservation network can be achieved at regional scale, regardless of strategy. Our "proactive" allocation scheme prioritized within corridors identified by the Florida Greenways project. Based on stakeholder guidance, we placed significantly higher priority on connectivity than is done under current programs. We used a 50% weighting of this decision criterion, as compared to the "Florida Forever" program's 10% weight. Nonetheless, there was not enough funding available in this time frame to achieve regional connectivity except at the highest funding levels.

The implications of this finding lead us to simulate a more refined regional conservation prioritization. In our final "proactive" strategy, we simulated the use of two forms of supplementary information in conservation prioritization. The first were estimates of likely future development within priority corridors. This is a somewhat controversial conservation planning idea. While in general our prioritizations simulate acquisition of land in order of ecological information alone, in the specific case of potential future conflict, our strategy purposefully acquires lands in advance of development pressure. This allows us to achieve demonstrably better conservation performance in the long run than a "pure ecology" strategy. However in Florida some of this land is already held by entities which appear to be speculating on future urban growth and zoning changes. Therefore, this is not the simplest strategy to implement, although it potentially makes the most efficient use possible of scarce taxpayer conservation dollars. The second form of strategic refinement was to increase the prioritization rank of remaining undeveloped habitat types predicted to be heavily impacted by sea level rise. As in the first refinement, this lead to demonstrable improvements in conservation efficiency, since habitat is acquired 'before' it is needed and conservation resources are directed away from some very expensive coastal lands which are predicted to be inundated. In this case, the change in strategy would likely be less controversial, expect that currently, or soon-to-be inundated lands may well be easier to acquire for conservation than drier upland areas. However, there may well be public safety and other good reasons for acquiring these lands, and their transitional habitat value may still be significant for many years. Regardless our conservation strategy looked for alternative upland areas, especially those connected to current conservation areas.

A third issue of interest to us was that existing statewide prioritizations available to us favored conservation over restoration. This was particularly apparent in the case of the Everglades Agricultural Area (EAA), although it was also true more generally. Given the strategic location of the EAA in hydrological terms, as well as its importance as a component of the historic Everglades system, we felt it important to generate several scenarios which considered the implication of restoring all or parts of this area. However, due to time, data and scope constraints, we were not able to investigate this issue in detail. Given the expressed interest of the Federal and State governments to purchase all or parts of this subarea, this would seem to be a high priority for future work.

Last but not least in terms of conservation findings, our scenarios located most new conservation on lands which are currently devoted to agriculture or ranching. Depending on the manner in which such conservation is organized, this has the potential to be either a large conflict, or an opportunity for considerable mutual benefit. There is significant native biodiversity remaining on private lands in this region, particularly on ranch and forest lands. The scenarios developed for this study can be used to develop "stakeholder maps" based on the overlay of conservation priorities with parcel ownership.

5.2 Climate Adaptation Planning Process

Next we turn to planning process aspects of the scenario generation process. While we conducted basic satisfaction surveys as part of our process, we had no formal control group, so the conclusions we can draw from the experience are somewhat limited. This study represents the first and largest regional climate change adaptation planning exercise conducted in this region. From participation records alone, we can claim some success in that hundreds of people voluntarily participated in this process, returning for multiple workshops and giving both their professional and personal time. From this point of view, the sponsoring agencies' funding and logistical support was well leveraged, since the process brought in considerable expertise not otherwise available in one place at one time. Because our engagement process actively sought out representatives from all of the sectoral areas might our core stakeholder group identified as priorities, we also achieved much broader representation than typical agency-level planning activities.

Our first conclusion, backed by participant survey results, is that the vast majority of working professionals in this area considered climate change adaptation planning to be an important and valuable activity. We are well aware that this topic is politically controversial among the public at large. We are also aware that there was necessarily selection bias in those who elected to participate. Nonetheless, we found people in every agency and NGO, at every level of practice and management not only willing to participate, but adamant about the importance of the broader task. This stands apart from discussion of any particular method. However it is a reasonable reflection of the need for some planning processes to be developed to tractably deal with these issues.

The initial parts of the project convinced us that while most decision makers know each other and were interested in these issues, they lacked a suitable organizational structure for creating an internal scenario simulation process. This limitation had experiential, technical and institutional origins. First, none of the participants had received prior training or had participated in prior spatial scenario planning exercises. Second, there was not sufficient geographic information systems or simulation modeling expertise among managers or their technical staffs to develop such an effort on their own. This is likely to remain true until and unless spatial planning, climatology and urban growth modeling are routinely taught in professional conservation planning education at basic and continuing levels. Absent such a substantial change in our educational system, all agencies and scientists conducting climate change adaptation planning are faced with a similar issue: how do you develop planning processes which bring in and use such expertise, especially in rapidly-evolving areas? More traditional approaches might involve having staff conduct background literature reviews or inviting in guest speakers. However these methods can be both professionally difficult and shallow. Asking an ecologist to review the primary literature on climate change modeling is an intimidating and awkward request. The joint creation of a comprehensive model using spatial data generated by others can be an effective alternative. The map (or model output), serves as what is known in sociology as a "boundary object." This allows interdisciplinary work to proceed without requiring each participant to be expert in each detail.

Finally, we noted a classic "principal agents" problem in scenario definition. Climate change and urbanization were widely acknowledged to be critical drivers of future scenarios, as were the potential actions of other stakeholders. But participating agencies were not in position to contribute to scenario development outside of their programmatic domains, especially in these two areas. Therefore, it was our observation that any viable form of scenario planning conducted under such circumstances would necessarily require additional resources and outside expertise. This is particularly apparent in terms of urban growth modeling and climate model downscaling. Currently, the Department of Interior is working to develop regional climate change centers which should eventually support the development of more regional expertise in these areas. This is an excellent step forward. However, based on our experience, we remain concerned that such efforts include professional incentives which recognize the free flow not only of scientific publications, but also of digital spatial modeling results. Unless significant attention is given to the means by which practicing conservation managers use new information, that information may well be generated in formats which are not conductive to interdisciplinary transfer and use.

Significant time and resources were taken in this study to develop an integrated and multidisciplinary approach. In particular, we made an early decision not to consider climate change independently of all other variables, but instead to develop a tractible but critical set of scenario dimensions. We were also careful to include "socioeconomic" uncertainties and not only biophysical ones. This is uncommon within the sciences and applied sciences, which are famously rife with professional divisions and which often ignore socioeconomic and political uncertainties. Our approach is by definition more difficult than taking a single-sector approach, for example looking at SLR alone. The question we must ask ourselves is: is it worth it? From a purely technical point of view, some sense of this can come from the presence, absence or magnitude of "interaction effects." In other words, if any one of the dimensions considered in this study had negligible impacts on the others, then it might be a candidate for focused and independent study within a single discipline.

As we have already seen in the substantive conclusions, we found the contrary. Each of the major scenario dimensions picked in this study had substantial and important interactions with the others. Climate change significantly affected human population patterns, which in turn impacted wildlife. The level of public resources in several cases had more influence on conservation pattern than the conservation strategy deployed. Land use planning variation had significant influences on the ability of people and wildlife to adapt to climate change.

From the less technical point of view, there are also other reasons for jointly considering multiple scenario dimensions. Even when it is scientifically more efficient to study each dimension separately, we must keep in mind the interaction between science and management. At some point, a manager responsible for a real world place or natural system will need to develop management actions. At that moment, the issue of interactions comes up again, not from the point of view of research efficiency, but from that of real-world interactions. For example, a manager who ignores resource limitations is unlikely to be successful if those impinge on potential activities. Likewise, consider the plight of a manger confronted with five different scientific studies, each excellent, but each using different climate change, management and population growth assumptions. The difficulty of this mental triangulation is a major potential barrier to effective and rapid update of the best available science into management practice.

In management terms, our scenario dimensions spanned several sectors traditionally planned and managed separately. In retrospect, the scenario dimensions chosen have stood up well, which is not surprising given that they were originally picked by conservation managers on the basis of their management importance. However, an important secondary issue has emerged in practice, and that is in the choice of dimension parameter values. In part due to the principal agent problem mentioned above, it has proven to be much more difficult to get agreement on these values, than on the overarching scenario dimensions. Consider the relative amount of sea level rise within a set of scenarios. In the case of the MIT scenario planning process, our stakeholders gave significant weight to the IPCC 2007 estimates. Nonetheless, for planning purposes, they choose to consider a range of variation including SLR greater than that in the current official IPCC scenarios. As this is written, in Spring 2011, this decision appears to have been wise, since most newly published science appears to indicate that higher levels of SLR are increasingly important to consider. Since the study was initiated, however, the Southern Florida Water Management district and the U.S. Army Corps of Engineers have both released official planning guidance which only considers more modest IPCC scenarios.

The issue of multiple, incompatible scenario planning processes is one which we recognized early within this process, but did not have sufficient authority to address. It remains an unsolved problem of increasing importance. Essentially, Southern Florida has a large number of relatively well-resourced planning entities. However, each sees its interests and responsibilities slightly differently, and at the time of study initiation none were willing to bind themselves voluntarily to a joint scenario planning process. At the same time, each institution was convinced of the utility of scenario planning in general, and committed significant internal funds to conduct separate exercises. Lacking an up-front commitment to coordination or cooperation, these efforts diverged to create different scenarios. In part influenced by observation of this process, representatives from Broward County lead an independent effort to generate standardized set of SLR scenarios across a 4-county region. This is laudable, and should greatly improve inter-county coordination and technology transfer. However we must note that these scenarios only addressed one aspect of climate change, and chose yet a third set of sea level rise intervals for their planning (not based on IPCC, but simply 1, 2 & 3 ft of SLR). Therefore, our arguments for integration and regional standardization have not been successful to date.

As of this writing, there are at least six sets of "climate change" related scenarios which have been produced for the region, and one other (pre-existing) regional urban growth simulation (Geoplan 2010). This is unfortunate in that it does not allow for direct comparisons and leads to significant replication of effort. However, it does add some robustness to scenario modeling for the region, since many more scenarios are investigated. It is our hope that with the conclusion of this study and release in multiple forms of documented scenarios and related GIS data, scenario efforts in the region can begin to converge with some attention being given to interoperability.

A second and somewhat related procedural issue is that of participatory process design. Because we elected to "open up" the modeling process, the related stakeholder participation process was necessarily long and relatively time-intensive for its participants. As described above, this involved many steps over many months, with the core stakeholder group vetting every major decision. In addition, we did extensive in-field research to validate model assumptions or components outside the expertise of stakeholder group participants. For example, we drove across the 30 county area and met with local climate change groups and county planners who were too distant to participate in regularly scheduled workshops. It is because of this extensive process that we feel comfortable that the modeling results reflect the major driving forces and regulations simulated across a broad and diverse study area. However, despite our extensive efforts in this regard, this outreach and informal peer-review was necessarily limited, particularly in regards to the depth of participation from several key stakeholders. We elected for expediency to go forward with this study based on the support of two federal agencies. In order to obtain the widest reasonable level of ecological and management expertise, we invited and actively encouraged participation from a much wider group of stakeholders, without precondition.

In retrospect, the project might have been better institutionalized if we had gotten a deeper level of commitment and involvement from the water management sector. These groups sent representatives and observed the process, but as described above elected to conduct their own parallel scenario planning processes. In addition to generating incompatible scenarios, this meant that our project did not have the resources to conduct scenario-based water modeling which considered new urban patterns. This would have led to a significantly improved overall assessment of scenario consequences.

The same could also be said for the ecological modeling community. We had participation from some of the leading modelers in the region, but no operating agreement which structured, organized and funded the ecological assessment of the scenarios. We have since actively pursued this goal with other groups, and have recently started a separate project with the state Fish and Wildlife Commission to assess the impacts of our scenarios on six species. However, the "decoupling" of scenario generation and species impact assessment, while professionally and managerially simpler, is not without consequence. In our follow-on work, we have learned about multiple aspects of regional scenarios which would improve the ability of scientists and modelers to more effectively assess their wildlife habitat impacts. For example, the scenarios presented here are silent as to water regime, storm surge and fire regime. This makes them less useful than might have been the case had vegetation and wildlife habitat modeling experts been involved in the scenario specification phase. We hope to be able to address these issues in future iterations of regional scenario refinement, but this comes at a "cost" of several years of lag time.

5.3 Limitations of Overall Process and Generated Scenarios

While we feel that the scenarios created are broadly useful and do reflect a wide range of conditions, we did run into a variety of data and modeling limitations which bear some scrutiny. Our decision to work comprehensively across a wide area meant that we built models which are regional in character, and in many particularities reflect aggregate average behaviors. This is mitigated to some extent by the use of very fine-scale data relative to most prior regional studies. In particular, our use of parcel-scale data allowed us much better spatial and temporal accuracy than studies dependent on land characteristics measured using remote sensing methods. Our database included roughly six million parcels with development timestamps taken annually over 50 years. This is a very large sample, spanning many subregional markets and many economic cycles. Similarly, we were able to take advantage of point-level business and employment data sources which represent the dispersed economic patterns of this region much better than the aggregated information typically available.

We faced several notable obstacles. The first was related to our decision in most cases to only include datasets in our analyses which were available at uniform scale across the region. It turns out that a number of very important models and datasets are available only for the Southern Florida Water Management District, or its sub-areas. This notably includes hydrological model outputs, which are available for complex subgeographies covering some critical areas, but not nearly all. Similarly, for sea level rise computations, we would have liked to use high-resolution LIDAR-derived terrain data uniformly across the region. While this was not possible due to limited data availability, we were able to integrate LIDAR data for some particularly critical Southeastern coastal areas and to compare it to terrain elevations derived from the basic USGS National Elevation Dataset data. In this particular case, we were able to make a hybrid multiresolution terrain model. However more generally, it would have been time and cost prohibitive to attempt to obtain and to integrate multiresolution datasets for each of the hundreds of layers used in scenario modeling.

Aside from data availability issues, we also faced a challenge in terms of the thematic scope of simulation modeling efforts undertaken. Because of our team expertise, we concentrated on urban land cover change modeling. However, we did not have the expertise or scientific data available to conduct similar dynamic modeling efforts for vegetation succession. Similarly, dynamic modeling of storm surge using models such as SLOSH (National Oceanic and Atmospheric Administration (NOAA) 2010; Jarvinen and Lawrence 1985) was outside of our scope and capabilities. Obviously, the addition of dynamic models such as these can yield a significantly more detailed picture of the risks in coastal areas. Initial indications are that such methods can yield significantly more challenging circumstances, much further inland than static coastal sea level rise methods might indicate. A more detailed investigation of sea level affects would also likely include an integrated ground and surface water model. Again, such modeling could not be incorporated because externally-developed models did not provide uniform coverage across the region, and we lacked the expertise to conduct such dynamic process simulation modeling ourselves.

6 Summary

Despite a variety of sociological and technological challenges, this project was successful in generating a wide range of "interestingly different" possible futures for the Greater Everglades region. We have summarized here the direct configuration and land use pattern implications of these scenarios, as well as the social and planning process choices which led to their current formulation. Future work by ourselves and hopefully by others will focus on more detailed investigations of the implications of these scenarios on conservation within the region.

Having completed the process, we consider its most valuable outcome not to be progress towards a single unified consensus vision for the region, but rather as a critical prior "preplanning" step for multiple potential planning efforts (Albert and Vargas-Moreno 2010). We believe that we have started to show how a set of regional scenarios can be useful to a variety of local stakeholders, which general components will be necessary, and how the process of stakeholder-based participatory simulation can improve local adaption planning capacity. The complexities and uncertainties involved are still great enough that we feel pushing forward prematurely with high-stakes plans would be a mistake. Yet we feel that a credible and useful climate change adaptation planning capacity will necessarily include most of the major elements initiated here.

Focusing resources on scenario planning as a process rather than a product leads us to a different set of implementation decisions and quality metrics. In particular, we think it will be valuable in future efforts to consider very carefully the concept of "social learning." Maurel et al. (2007) have defined this as the "growing capacity of a social network to develop and perform collective actions." Because potential consequences are serious, it is important to create a space for creativity, solution generation and reflection. This can help decision makers see policies and actions in the first place not as commitments, but rather as experiments worthy of testing, simulation and discussion with peers. This requires the planning processes to be reformulated and reinterpreted to accommodate not only new issues, but new ways of working within and across disciplines and institutions.

This type of work requires a certain degree of professional bravery from all concerned. None of us were professionally trained in climate change planning, so we must be as transparent as possible about the processes used and attempt to learn from our own mistakes. We feel that participatory spatial scenario simulation has an important role to play in climate change planning for conservation, but within this broad set of methods there are still many choices with very limited theoretical or practical guidance available. We close by thanking once again our stakeholder group, whose contributions of time and knowledge were critical to the success of this project.

Interactive digital versions of the scenarios and their documentation, in graphical as well as GIS form, are available from the web site: http://geoadaptive.com/everglades.

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Chapter 4
Using "Spatial Resilience Planning" to Test Climate-Adaptive Conservation Strategies

Michael Flaxman and Juan Carlos Vargas-Moreno

Abstract How can we plan more effective conservation networks in the face of climate change, urbanization pressure and financial and policy uncertainty? We have developed and present here a strategy which we call "spatial resilience planning" or SRP. The method is an extension of "alternative futures" scenario planning (Steinitz et al. 2003) and builds from the same social and technological infrastructure. It relies on stakeholder-based participatory simulation to generate a set of scenarios which encapsulate the major uncertainties and choices faced within a geographically-bounded area. It also uses formal spatial impact models to assess the consequences of scenarios to species, habitats and to people. The difference between SRP and conventional scenario planning is in the way the scenarios are organized and tested. SRP draws a clear separation between "planning actions" (which are within the domain of influence of participating stakeholders) and all other "drivers of change." It asks the question: which are the planning actions under stakeholder influence that might best accomplish stated goals in the face of significant and uncertain exogenous forces? This can be considered a form of "policy sensitivity testing." This chapter presents a first example of this approach, in the context of Florida conservation planning under climate change.

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1 Overview

Scenario-based planning and "alternative futures" impact analyses have been show to be an effective way to organize divergent views in considering a range of options for future (Schwartz 1996; Schoemaker 1995). These methods have been widely deployed in landscape and transportation planning (Baker 2004; Godet 2001; Hulse et al. 2004; Pellier and Fiorino 2004). Conservation planning, however, operates in a slightly different context – a world in which it exerts very limited control. This domain requires less of a single fixed plan and more of an adaptive strategy. How can we effectively transition from one to the other?

Our research group has begun to develop an integrated climate adaptation planning approach we call "spatial resilience planning" (SRP). SRP is designed to generate plans and strategies which are robust relative to uncertainty. While motivated by the need to plan for climate change adaptation, the approach can also accommodate multiple types of variability, including uncertainty about future political choices or human behavior. The method is an extension of "alternative futures" scenario planning (Steinitz et al. 2003) and builds from the same social and technological infrastructure. It relies on stakeholder-based participatory simulation to generate a set of scenarios which encapsulate the major uncertainties and choices faced within a geographically-bounded area. Just as in alternative futures planning, spatial impact models are used to assess the differences between plans or policies. The difference lies in the ways in which the scenarios are organized and tested. SRP draws a clear separation between "planning actions" and all others, and it uses a sensitivity testing approach to explore the relationships between plan performance and a variety of exogenous forces. By doing so, it clarifies and quantifies the likely performance of plans which control only a few things, in a world where many other things may be changing simultaneously. It goes beyond the traditional stopping point of physical planning to investigate the question of strategy in the context of geographic knowledge.

To illustrate the approach, let us consider here the issue of conservation network design for Florida under the combination of sea level rise and human land use changes. We use as the basis for this investigation the "alternative futures" generated by the broader Everglades study described in the preceding chapter by Vargas-Moreno and Flaxman (2012). Our study area is the Greater Florida Everglades, and contributing upstream areas – a 30 county region extending from Central to Southern Florida (see Fig. 4.1).

We consider here two distinctly different conservation strategies for a 30 county region in South and Central Florida over a 50 year period. The baseline conservation model emulates current practices, which focus on piecewise preservation of the land of highest current conservation value regardless of development pressure or land cost. An alternative "proactive" strategy uses forward estimates of climate change and human development patterns to conserve lands well in advance of potential need. Both strategies are simulated spatially and temporally using a range of conservation budgets, and variations in biophysical and political climates.

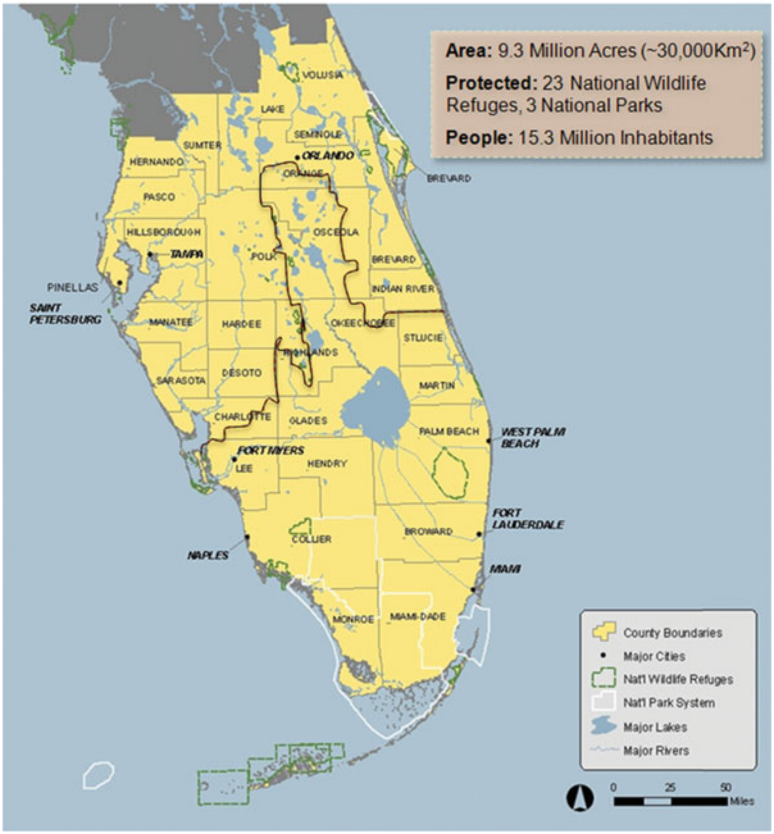


Fig. 4.1 Study area

How can we tell which strategy is more effective? The standard formulation might be to create one scenario for each strategy, then consider how each impacts various species and habitats. However, this common practice has a deep and significant flaw – it implicitly evaluates performance relative to a single model of the future. For such a comparison to be meaningful, we need highly accurate models of that single future, in this case 50 years in advance. As experienced planners and modelers, we find this notion somewhere between naïve and dangerous. Instead, we prefer to be extremely humble about our ability to project the future, and to invest significant energy in systematically exploring major points of uncertainty or policy disagreement. Only when we assess our strategy against a realistic range of conditions can we have any confidence in its likely performance.

In addition to being technically more sensible, this approach has numerous beneficial social side-effects. Because the process is anticipatory and inherently multidisiplinary, it creates an opportunity for people to think about how forces which they don't typically control affect their area of responsibility. Essentially, it gives people time and mandate to put aside their daily work and think longer term and more strategically. Second, because it can simultaneously accommodate very different points of view, it avoids political and values fights which frequently characterize other single-future processes. There is no need to achieve artificial consensus on one view of the future – several ideas can be pursued simultaneously. Finally, the process supports adaptive planning by seriously considering a range of conditions and actions. When people have already considered major uncertainties, they are better prepared when trends or policy decisions begin to favor one particular set of contextual scenarios over others. For example, when the political and economic environment swings in a direction challenging to conservation, they can have some practical advantage from having already considered this and designed strategies likely to be as effective as possible in this circumstance.

This work was inspired by the concept of "resilience" was first elaborated by the ecologist C. S. (Buzz) Holling in 1973 and extended by himself and others in multiple papers (Hulse and Gregory 2004; Plummer and Armitage 2007; Folke et al. 2004). Holling defined resilience as a measure of how far a system could be perturbed without shifting to a different regime. His description went beyond strictly ecological systems and considered those in which human management was integral. We use the term in a related fashion but from dual vantage points. First, like Holling, we think it is unarguably important to consider natural systems as (a) dynamic and (b) systems. Conventional planning based on static map overlay can easily miss both of these points. We must begin to develop methods which work on a "shifting basemap." This point was most memorably made by someone working in a very dynamic field not usually associated with planning, hockey star Wayne Gretzky: "I skate to where the puck is going to be, not where it has been." In our opinion, too much of current conservation planning is chasing after the puck, and not enough in figuring out where we need to be. SRP assumes that the future is uncertain and dependent on the actions of others who do not necessarily share the same goals. However, by explicitly simulating possible futures, we can literally generate maps of where conservation needs to be. By testing our own strategies under realistic resource constraints, we are also able to judge how best to get there.

The second aspect of Holling's thinking – consideration of the resilience of coupled human and natural systems – remains highly challenging. The impact measures which we deploy in this study are relatively comprehensive, but individually and collectively simplistic. Our approach is able to accommodate more detailed and elaborate consideration of adaptive mechanisms, but working regionally, we are drawn to consider large-scale, essentially irreversible decisions such as whether and where development is permitted.

In an important sense, we go beyond Holling's original focus on ecological resilience, and consider resilience in a specific form of human activity not normally associated with flexibility or adaptability – the process of plan making. We find virtue in plans and planning processes themselves being resilient. Plans are critical to effective conservation, and more generally to joint long-term societal actions. But they are typically closely argued and very time consuming and difficult to modify or re-create. A plan which cannot accommodate a contextual change is either a "dead plan” (not taken seriously and therefore not functioning), or perhaps worse a “faulty plan” (continuing to operate and influence decisions even though its premises are known to be wrong).

This chapter is organized as follows. First we consider our planning context and how prior methods have attempted to deal with land use, ecology, climate change and their interactions. Then we will describe the methods we have deployed, how these play out in the specific context of Florida. Finally, we will explore which more general lessons can be taken from this example.

2 Early Twenty-First Century Planning Context and the Florida Case

The primary challenge in conservation planning is that of competing land uses. In the nineteenth and twentieth centuries, these included agricultural, forestry and industrial uses. However in the twenty-first century it is already clear that the major competing uses are related to human settlement and transportation. In particular, internet and communications technologies together with historically low automobile and air transportation costs continue a long term trend toward lower density settlement at the fringes of major urban areas. This combines in the U.S. context with two demographic trends: the retirement of the relatively-affluent and healthy post-war baby boom, and a general shift in populations from historic manufacturing centers towards the “sunbelt” and generally into coastal zones According to an analysis of census data, these trends have been relatively consistent over a 40 year period (Conway and Rork 2010). A good summary of these compounding forces can be found in a recent Pew Center report (Beach 2002). The key issues to note are that (1) coastal areas by Pew’s definition constitute 17% of the nation’s land area, but over half of its population, and that (2) the number of miles driven per person has consistently increased by 4x the rate of population growth over a 50-year period.

Even without considering climate change, these socioeconomic factors combine with fragmented land use and transportation systems to pose a serious conservation governance challenge. Essentially, the full value of conservation is not recognized in our economic system, either at individual or institutional levels. This is generally true for most private lands, including the many of the most ecologically-important. The only legal barriers to development are based on zoning constraints, or the documented presence of particular endangered species or wetlands. This regulatory system is for the most part fragmented, weak and easily outflanked. For example, despite an official policy of “no net loss” of wetlands, in recent years the U.S. Army Corps of Engineers has granted over 99% of wetland fill permit requests in Florida, with more than 100,000 acres of loss officially permitted (Pittman and Waite 2009). The result is a familiar catalog of ecological decline, depressingly similar whether measured in terms of species, habitats, water or other resources.

Therefore the general purpose of broad-scaled conservation planning is to help develop strategies which can inform both public and private voluntary conservation activities. On the public sector side, these should tie into existing fee-simple conservation acquisition, comprehensive planning, endangered species habitat planning and wetlands planning efforts. On the public-private partnership side, these should help guide individual and voluntary land stewardship activities, including land management practices and conservation easements. In both cases, it is of great benefit to operate well-ahead of market pressures and to attempt to link conservation activities into a strategy which considers comprehensively which activities occur when, where, and by whom. These have different time windows depending on investor risk tolerance, but are generally less than 5 years for private developers, and somewhat longer for agriculturalists and ranchers with major land assets (Chicoine 1981; Goldberg 1974).

3 Drivers of Change

Recent work in conservation planning has concentrated on how shifting habitats and species populations may affect biodiversity conservation (Burkett and Kusler 2000; Feagin et al. 2005; LaFever et al. 2007; Parmesan 2006). This is clearly important, but unfortunately addresses at best only half of the challenge. It is equally important to recognize that ecological stressors are now themselves being altered by climate change. First, there is every reason to believe that human populations will adapt and shift in response to climate change (Stephenson et al. 2010; Moser 2005; Plummer and Armitage 2007). Those responses potentially affect not only settlement patterns, but also many other sectors and land uses impacting conservation, for instance including fisheries, agriculture and forestry. Second, as supplies of natural resources such as water become less reliable, ecological systems will likely face additional competition from human consumptive uses (Burkett and Kusler 2000; Diamond 2005). Third – and more positively – human choices and policies for climate change mitigation provide an opportunity to alter economic, transportation and land use decisions in ways which might much better support conservation (Sheppard et al. 2011).

The influences of urbanization, climate change and land use planning constraints are all individually well-studied within conservation planning, yet interactions between these driving forces are rarely considered. This situation has led to repeated calls over at least a decade for integrated analyses, as well as a recent review which concludes "studies that include only one or the other driver are likely to inadequately assess impacts (de Chazal and Rounsevell 2009)."

One possible approach is to attempt to "downscale" global climate scenarios not only in terms of their impacts on regional climate, but also in their assumptions about regional socioeconomic trajectories. Solecki and Oliveri simulated how climate change might impact urban growth in terms of assumed influence on land use demand (Solecki and Oliveri 2004). However, the great difficulty with this approach is that there are myriad regional and state-level scenarios which are consonant with a global scenario, and a direct interpolation of global trends across all spatial scales can be counter-factual. National population shifts are driven by forces not considered in global estimates. Therefore, while it might make sense to craft U.S. national scenarios to be nested within global ones in terms of total population, it makes little sense to think about Florida's future population as a simple proportional downscaling of U.S. population. Florida's percentage share of the U.S. domestic population has not remained constant for the last 50 years, and there is no plausible reason to believe it will do so for the next decades (Flynn et al. 1985; Conway and Rork 2010). Conventional demographic analyses developed by University of Florida researchers are available. These estimates have been conducted over a 40 year period and are typically accurate to within better than 2% per decade, with more recent estimates being even more accurate (Banko 2011). The bigger issue this points out is methodological: how can "top down" scenario planning methods be melded with "bottom up" regional scenarios? In the specific case mentioned, the overall population equation balances because of domestic and international migration. However, this is not necessarily the case.

The question of likely human adaptation measures is clearly an important one. However, the literature in this regard remains surprisingly limited. An outline of the major challenges was developed by Tol and colleagues in 1998: "Most of the studies of climate change impacts tend to make simple assumptions about adaptation. They either ignore adaptation completely, or assume arbitrary measures or complete changes in behavior, infrastructure, and institutions without examining the costs and feasibility of changes." (Tol et al. 1998). There is no shortage of vulnerability assessments, but these fall short of projecting likely responses, in large part because they ignore behavioral issues, costs, or both. Since there are few appropriate example cases to draw from, we are left to reason by analogy to other types of risk/response, or to consider qualitative typologies of recommended actions. The most recent and relevant study of climate change risks in Florida was produced by Tufts University (Stanton et al. 2007). Among its major findings are that sea level rise and storm surge in particular could threaten billions of dollars in coastal development and associated infrastructure. What people choose to do will likely have much to do with not only how much climate change occurs, but also who pays for what, and which rules govern.

4 Conservation Consequences of Changes

In terms of ecological responses, the challenge of climate change planning for conservation was well characterized by Opdam and Wascher (2004). They developed a conceptual model which makes the point that key interactions occur at two scales. At biogeographic scales, climatic factors are well known to limit species ranges, either directly through biological sensitivities or indirectly through impacts on habitat and intraspecific competitive advantage. Meanwhile, at landscape scales, species metapopulation theory indicates that the availability and organization of habitat can influence species viability. In a habitat-constrained, climate-changing world, these two scales interact. As Opdam and Wascher put it "the response chain from climate change to distribution pattern is mediated by landscape cohesion. (idib)"

Using very different techniques, Iverson and Prasad (1998) came to similar recommendations. They used regression tree modeling techniques to predict future vegetation ranges under various climate change scenarios, concluding that "given these potential future distributions, actual species redistributions will be controlled by migration rates possible through fragmented landscapes." Finally, recent work in a very different region re-affirms the potential importance of climate-land use interactions at landscape scales. Working in the Andes, (Feeley and Silman 2010) predicted the distributional responses of hundreds of plant species to changes in temperature incorporating population density distributions, migration rates, and patterns of human landuse. In this landscape, they found an "overriding influence of land-use on the predicted responses of Andean species to climate change."

At a very detailed level, there are numerous studies which consider how individual adaptation or mitigation mechanisms might impact biodiversity. Of particular relevance to Florida are studies which investigate the impacts of existing mechanisms for coastal "armoring." This is a potentially likely response in certain parts of Florida, although its utility is severely limited in many cases by very pervious limestone geology. (In such areas, measures such as installing rip-wrap can be somewhat effective in mitigating storm surge, but not base tidal inundation.) An example of the known effects, based on a paired "natural experiments" method, show significant effects on shorebirds (2x less species richness and 3x less abundance on armored segments) (Dugan et al. 2008). Birds which use beaches primarily for roosting showed even strong effects (ranging from 4x to 7x reductions on armored segments) (ibid.). Clearly, there is room for concern that single-purpose adaptation mechanisms designed to protect property could have significant inadvertent impacts on wildlife. While specific results are likely to vary highly dependent on local context, the combination of climate change and land use change are pervasive enough to merit the development of a consistent set of methods.

5 Strategy of Selected Simulation Approach

A detailed elaboration of the AttCon simulation modeling process and its application to Florida can be found elsewhere (Flaxman and Li 2009; Vargas-Moreno 2011). In basic terms, we chose to deploy a rule-based deterministic land use allocation model. The choice was motivated by two primary factors. The first was that the research team felt that future land use changes in the region would vary significantly from historic trends based on scenario constraints. Therefore, statistically-based models would not be appropriate, since we wanted to be able to investigate the relationship between rules and responses. The second was that the model had pedagogical as well as predictive purpose, and needed to be run at least 24 times across a very large region. This argued for use of a deterministic model which accepted exogenous predictions of population growth, rather than a microsimulation approach.

In the AttCon modeling formulation, potential development units are allocated based on an estimate of relative suitability for a specific purpose, and conflicts are resolved using an explicit prioritization scheme which defaults to economic willingness to pay under "business as usual" scenarios. Under proactive scenarios, public purposes are allowed first right of refusal within the allocation scheme, under the assumption that government can choose to intervene. This allows a single consistent method for allocation of conservation lands, given a prioritization and an acquisition budget.

The major refinement required relative to prior implementations was an integrated submodel simulating sea level rise and human response to it. This task is somewhat simpler in Florida than in other areas because most coastal areas are very flat and composed of pervious limestone geology. This means that adaptation options are relatively limited, since sea walls and dikes are infeasible. This made it feasible to use a simple "bathtub" model of mean high tide sea level to estimate tidal inundation based on projected SLR. It should be noted that two important sources of risk and their relation to climate change were not accounted for due to modeling limitations. We were unable to consider storm surge, since this requires dynamic modeling considering near off-shore bathymetry. We also could not consider changes to hurricane frequency or intensity, since data linking these phenomena to climate change are not spatially available for the region. Both of these factors would likely compound the effects which we are able to estimate using simple SLR modeling.

The SLR model provided the basic environmental hazard information needed to project human response. Our AttCon model is able to track and project the major physical structure and socioeconomic characteristics which would likely be relevant. Because the model simulates the allocation of different real estate submarkets, it understands both the income characteristics of a given location and the age and type of built structures. We might expect to find different responses based on median income and physical structure characteristics. However, because actual empirical response data are not available, we were faced with the dilemma identified in our literature review – how to account for varied but realistic responses to coastal inundation. Dozens to hundreds of potential adaptation responses have been suggested in the literature and each of these individually and collectively could have wildlife impacts. Because of the wide variety of potential mechanisms and lack of literature on preferred responses given issues of cost, practicality and institutional barriers, we chose abstract the options.

In spatial terms, there are basically four coastal climate adaptation strategies available. The first is "adapt in place." This means that the basic form of activity remains in the same location, with whichever adjustments are needed to buildings, conservation, infrastructure or current land use practices. The second is "shift locally." This means that the same activity continues in the nearest available location, which strong preference to those areas under the same management authority as the original location. The third is to "move regionally." An existing use continues to persist, but is forced to relocate within the same region. The forth is to "quit or move long distance." In this case, a function either disappears entirely, or moves entirely away from the region in question.

The first-order task in considering human land use responses to climate change is to consider likely responses relative to this spectrum of basic adaptation types. For a given biophysical or socioeconomic condition, this could be a single response, or a probability distribution. For example, consider coastal condominium buildings under historic to current levels of coastal hazard, sea level rise and storm surge. Something close to 100% of this land use type adapts in place, typically rebuilding unless legally prohibited. Under a sea level rise scenario in which the same use is inundated at every high tide and insurance rates rise dramatically or insurance is no longer available, the response curve is likely to shift considerably.

Pending further empirical research into the likely values for such basic adaptation types, we chose to implement a simplified decision rule which is described below. For now, we simply note the dilemma faced in such a circumstance: there are many cases in simulating alternative futures where human attitudes towards future events and circumstances are important but unknown. The scenario formulation does not avoid this, but does allow us to press forward with clearly stated assumptions. Using spatial resilience planning methods, we can also test the relative importance of these assumptions, and direct future research toward their clarification. For example, we could survey appropriate groups about their likely response within scenario conditions.

Such changes are in detail unpredictable, and subject to significant uncertainties. This has led some to adopt a “wait and see” position, attempting to defer such analyses until more definitive science is available. However, we believe that this is a fundamental strategic mistake. Conservation planning is a social learning process, not simply a matter of technical analysis. New issues and information must be deliberated within a number of public and private decision-making processes before actions can be initiated. The key challenge of conservation planning under climate change is not to come up with single decision based on new information or analysis. The challenge is to develop planning methods and decision-making structures which are able to routinely incorporate uncertainty, changes in science and conflicting human values. While climate science is improving rapidly, human adaptation and political decision-making is integral and will remain inherently unpredictable. Therefore, we must develop and test planning methods now which are capable of routinely incorporating new information and which are robust in the face of both scientific and political uncertainty.

6 Methods

Spatial Resilience Planning or SRP can be considered a technique for using scenarios to generate and refine plans. Two basic steps are required. The first is to separate “exogenous” and “endogenous” scenario variables. Exogenous variables are used to develop “contextual” scenarios, and the endogenous factors to develop “designs” or “plans.” In the context of stakeholder-based planning, exogenous variables are those which the group does not have substantial power to change or influence. In most locations, these include global climate change, national and international economics, and population in- and out-migration. Endogenous variables are the opposite: these include aspects of management discretion and policy in which there is significant choice. In our case study area, these decisions included how to manage current conservation areas, which additional lands to conserve, and which types of conservation actions to deploy. These decisions are not unconstrained: managers have limited legal discretion, jurisdiction and budgets. But within these constraints, very real decisions must be made.

The second step of SRP is to explicitly “stress test” plans against exogenous contexts. This can be done for plans as a whole, or for specific plan elements or parameters. In this case, we bundled a set of conservation strategies into a group we term “proactive,” but varied the level of financial resources provided. Because both aggregate scenarios and their component elements do not have explicit probabilities assigned to them, we are limited in the degree to which we can quantify resilience. Here we deploy a basic, but effective mechanism: we spatially identify the frequency and nature of conflicts between an endogenous scenario element and the full scenario set.

In our specific case, we summarize the area in which conservation is possible given exogenous constraints. At an aggregate level, such “conflict analyses” are an indicator of plan performance. By this measure, a resilient plan is one which is relatively robust in the face of a wide range of scenarios, but still accomplishes its objectives. This dimension of plan performance is complementary to more traditional ecological performance metrics, which can also be computed from the same input data. Therefore, an “effective” plan may be one which scores highly according to multiple ecological or social criteria and is resilient. Finally, an important aspect of spatial planning is that our conflict analysis and resilience measures are themselves spatially variant. They can therefore indicate which areas or regions are relatively more or less impacted, and where strategies are effective or not. This provides important opportunities to geographically tailor policies so as to improve plan performance across different socioeconomic and environmental conditions. In this example, we only look at a single round of conservation strategy design. But the results from conflict mapping could be used in detail to look for other areas which met the same goals, in a process of iterative refinement.

7 Contextual Scenarios

Our contextual scenarios were scoped and developed using an in-depth participatory spatial simulation modeling approach. For our purposes here we only outline the major driving variables considered in the process – a detailed description of the scenarios and modeling process is provided in the previous chapter (Vargas-Moreno 2011). Participants in this process created a set of scenarios which recognized four top-level dimensions: climate change, human population demographics

Assumption Type (Variation from Current)	Climate Change (SLR shown)	Population	Water & Land Use Planning Assumptions	Availability of Financial Resources
Low	9” by 2060	Trend (+28m)	“Business as Usual”	Low
Medium	18” by 2060	Doubling (30m)	-	-
High	36” by 2060	-	“Proactive”	High
Individual Possibilities	3	2	2	2
Cumulative Possibilities	3	6	12	24

Fig. 4.2 Contextual scenario parameter matrix

and preferences, availability of financial resources, and land and water policies. For each dimension, stakeholders developed a bounded set of parameter values or assumptions. For example, qualitative descriptions of climate change included low, medium and high groupings, each quantitatively defined in terms of sea level rise, temperature, and precipitation based on IPCC 2007 model outputs (IPCC 2007). The land, water and conservation rules dimension was the most complex, with over 100 separate policies considered and packaged into two major grouping: “business as usual” (B.A.U) and “proactive.”

The “alternative futures” portion of the study developed and discussed five priority scenarios, which reflected managers’ priorities for the most important multidimensional combinations. In order to limit the potential propagation of scenarios, stakeholders were encouraged to strictly limit the number of dimensions and choices along each dimension. Based on the stakeholder’s allocation of these resources, this had the consequence of reducing consideration of moderate water and land use planning assumptions and financial resources. Also note that stakeholders chose to include one climate change scenario that was higher than IPCC standard 2007 scenarios and reflected the possibility of non-linear melting of the Greenland ice sheets.

In order to conduct the sensitivity testing required by this approach, we simulated every logical combination of the major driving variables, leading to a total of 24 scenarios. This set incorporated three levels of climate change, two levels of human population change, two sets of land and water management policies, and two levels of public finance. While significant additional setup and computing time was required, we were able to use the same AttCon simulation model (Fig. 4.2) (Flaxman and Li 2009).

8 Simulation Modeling Using AttCon

After initial scenario assumptions and parameters were validated with stakeholders, we constructed a spatial simulation model projecting future changes in land use for the region. In this case, we simulated seven land use types: high, middle and low-end urban residential housing, rural residential development, agriculture, ranching and conservation.

We also included a simulation of sea level rise (SLR). We used a simple "bath-tub" model based on projected sea level in 2020, 2040 and 2060, terrain elevation and contiguity with the ocean. All areas under mean sea level and contiguous with ocean were considered permanently inundated. Our overall terrain surface was obtained from USGS's National Elevation Dataset. We refined this terrain by overlaying LIDAR-based bald earth terrain elevation data from NOAA and from the Everglades Depth Estimation Network (EDEN) where available.

Since we were unable to find scientific literature providing more appropriate guidance on human responses to sea level rise,, we simulated two logical possibilities. In our "business as usual" scenarios, we allowed building wherever economic pressure and zoning allowed it. Where developed land was inundated, we assumed that a certain percentage of previous residents would stay within our study area, and the rest would leave it. Those who stayed would exhibit the same land use preferences as prior to inundation, and would essentially be displaced within the region. In our "proactive" scenarios, we implemented a form of zoning which blocked any new development from areas subject to future sea level rise. Where current residents were displaced by SLR, we made the same assumptions about redistribution as in the other scenarios – for example that 85% would stay and 15% would leave.

The outputs of the model are projected land uses (and inundation) over time, in the form of raster GIS grids. Typical model outputs are shown in Fig. 4.6.

9 Conservation Design and Plan Simulation

There have been multiple generations of plans for the conservation of the Greater Florida Everglades, and for Florida as a whole. Our interest is this study was not to replicate such efforts, but instead to consider how resilient they may be to climate change, urbanization and other pressures. To estimate conservation attractiveness under current plans, we blended two proposals: the Critical Lands and Waters Identification Project (CLIP)(Oetting and Hoctor 2007) and the Florida Ecological Greenways Network (Hoctor and Center 2004). CLIP was developed by researchers at the University of Florida and the Florida Natural Areas Inventory for the Florida Fish and Wildlife Commission (Oetting and Hoctor 2007). The Greenways network was developed by the University of Florida GeoPlan Center and Florida Dept. of Environmental Protection (DEP), Office of Greenways & Trails (Hoctor 2001).

Both existing plans have been published electronically in GIS form by their respective authors, greatly facilitating this kind of analysis. However, both plans exceeded likely short-run conservation resources by a very wide margin. We therefore found it necessary to develop temporal "phasing" in order to make the plans and their relative priorities explicit in our simulations. For this reason, the resulting analyses reflect our estimation of the likely implementation of these plans, based on the priorities expressed within them.

In our composite conservation attractiveness model, we used CLIP priorities as our top priority areas, passing through their rankings directly. Therefore, our top priority areas are identical in location and extent to CLIP's. We then underlayed the Florida Greenways priorities, ranking them as "next most" attractive while maintaining their relative internal ranking order. All analyses were conducted using 50 m × 50 m (1/4 ha) grid cells. In our conservation allocations, we used distance to existing conservation as a "tie-breaker" between identically-ranked grid cells.

9.1 Conservation Strategies

Our key "endogenous" variable was conservation strategy. This took one of two forms. Under "business as usual" scenarios, we attempted to replicate current conservation practice. Based on review of the Florida Forever program and CLIP prioritization, we used a so-called "greedy" algorithm. This took each potential conservation acquisition in rank priority order, based on availability of land and funds. We did not attempt to replicate a portfolio-based method, because that did not reflect what we had observed occurring in practice.

In the "proactive" conservation scenarios, we simulated a rather different strategy, but for fairness in comparison using the same greedy algorithm. We used the contextual scenarios to grant the proactive method full forehand knowledge of future land use, and allowed it to re-prioritorize acquisitions based on this knowledge. In particular, the proactive scenario placed as its highest priority lands which would otherwise become urbanized, and lands which formed potential "climate corridors" connecting habitat likely to be inundated under SLR to the nearest large protected natural areas.

9.2 Conservation "Demand"

Conservation "demand" estimates varied by scenario based on both policy and financial resources availability. We began by considering this history of land conservation over the last 50 years. For the most recent decade, we used a full parcel-scale GIS database of acquisitions provided to us by the Florida Natural Areas Inventory (Oetting J 2010, Personal communication). This was "clipped" spatially to our study area to provide a relatively exact measure with purchase prices, acreages and acquisition

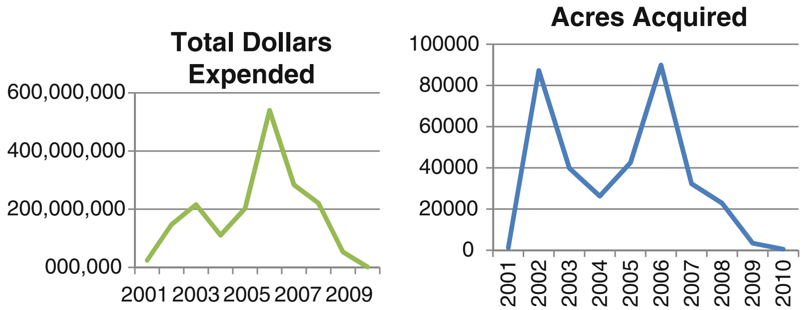


Fig. 4.3 Historic conservation land acquisition in South Central Florida

dates. For the period from the 1960s to the 1990s, we were only able to obtain program-level aggregations of total acreages and costs over a project lifetime (Oetting J 2010, Personal communication). We pooled all of this data, estimating annual acquisitions for project-level data using simple averages.

For "business as usual" scenarios under typical resource availability, we extrapolated mean historic conservation acquisition rates over the last 50 years forward 50 years. For proactive conservation demand, we used multipliers of historic rates based on financial resource availability. These estimates do not include other conservation activities such as fully-private conservation efforts. However, fully private conservation in the last decade in Florida has accounted for only approximately 10% of total acreage (Oetting 2010, Personal communication). Our dataset did include all public-private partnerships and Federally-funded acquisitions such as those undertaken as part of the Comprehensive Everglades Restoration Project (CERP).

The main current conservation lands program within the state is known as "Florida Forever." While originally budgeted at $300 million per year, this program has recently been underfunded because of the Florida state budget crisis. Over the last decade, however, the program achieved just under two-thirds of its original intended scope. Relative to other state acquisition programs, this accounted for a still-impressive $1.8 billion dollars in conservation lands acquisition; purchasing 621,000 acres.

Predicting future conservation budgets is obviously very difficult, and subject to substantial uncertainty. Annual plots show considerable variation over the last decade, with a very negative recent trend. However, this is also an advantage of a scenario-based approach, since we can simultaneously consider multiple possibilities (Fig. 4.3).

Note that our formulation of conservation "demand" embeds the notion of societal "willingness to pay" based on empirical estimates. This varies from ecological optimization-based concepts such as "irreplaceability" and "functional redundancy" (Margules and Pressey 2000). This is a measure of likely available conservation resources scaled to a particular place, not a conservation goal. The difference is very dramatic in the case of Florida. The total land area included in the CLIP and Florida Greeways prioritizations covers more than 50% of the total land area of the state, and the current total fraction of conservation land across the state is 28%. This difference represents millions of acres and billions of dollars. Therefore, our conservation simulation results are sensitive to which decisions are made "within" the overall prioritization schemes in actual active use, as well as to variations in overall conservation budget. For example, our current conservation simulations reflect actual practice in which the prioritization schemes used are biologically-driven and do not explicitly consider land cost. In recent conservation efforts, the average land cost was just under $3,000 per acre. However, the most expensive parcels acquired were approximately $2,000,000 per acre (occurring mostly in the Florida Keys).

10 Results

10.1 Overall Urban Pattern

Our contextual simulations projected a wide range of urban land use drivers over the next 50 years, depending on the population estimates, level of financial resources and land use policies in effect. What kind of variations did this cause? The simplest aggregate measure is development frequency. In raw form, this is simply the count of scenarios in which a particular location was urbanized, ranging in this case from 0 to 24. This can obviously be normalized to a percentage score, but for simplicity in representation, we chose to reclassify it into three categories: land not urbanized under any scenario, land urbanized in less than 50% of the scenarios, and land urbanized in more than 50% of the scenarios. This classification can be seen in Figs. 4.4 and 4.5.

In general, allocations remained relatively faithful to existing spatial patterns, which is a reflection both of the conservative nature of the rules used to generate them and the lack of new geographic limits, transportation corridors, or ownership constraints. For example, all scenarios showed continued population growth along both coasts. However, the major change evident relative to historic trend is the vast amount of development in the Northwest and Northcentral portions of our study area (Fig. 4.6).

10.2 Conservation Amount and Pattern

Our most striking finding is that sea level rise under most scenarios may inundate much more land than is being added to the conservation network. For example, under our high climate change scenario (1 m SLR by 2060) with "business as usual" conservation, 0.28 million acres of conservation are acquired. However, under the same scenario, 1.25 million acres of conservation land are lost to sea level rise. The effects of sea level rise vary across the region, but are particularly pronounced in the Florida Keys, and in the Southwestern corner of the state (see Fig. 4.6).

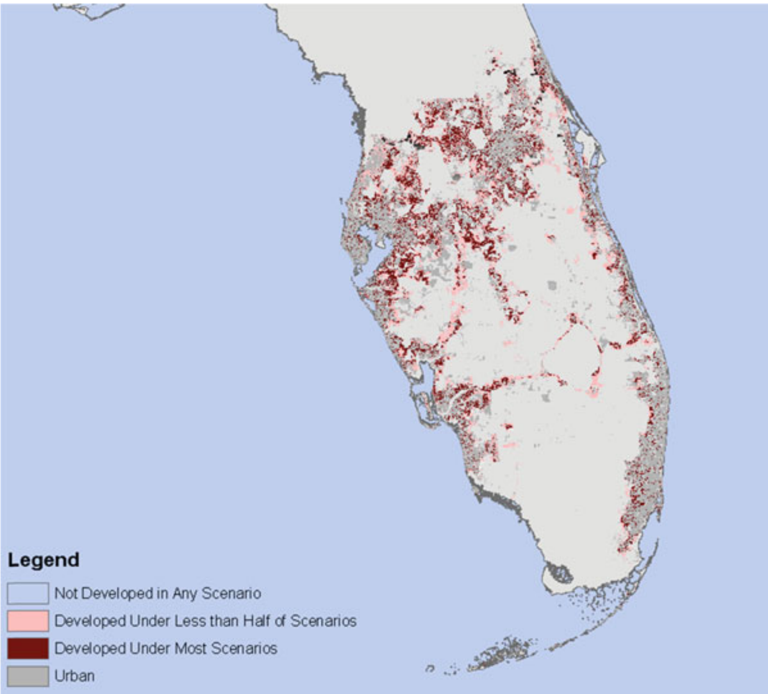


Fig. 4.4 Urbanization pressure across 24 scenarios

Development	Cells	Hectares	Acres	% Total
None (0 scenarios)	26,598,366	6,649,592	16,889,962	85%
Moderate (1-12 scenarios)	2,470,182	617,546	1,568,566	8%
High (12-24 scenarios)	2,161,654	540,414	1,372,650	7%
Total	31,230,202	7,807,551	19,831,178	100%

Fig. 4.5 Development pressure across multiple scenarios

It is perhaps not surprising that coastal wildlife refuges are at risk from SLR. However, the proportions of land lost are striking. In all but the lowest SLR scenarios, upwards of 50% of the existing coastal national wildlife refuges will be inundated (Fig. 4.7).

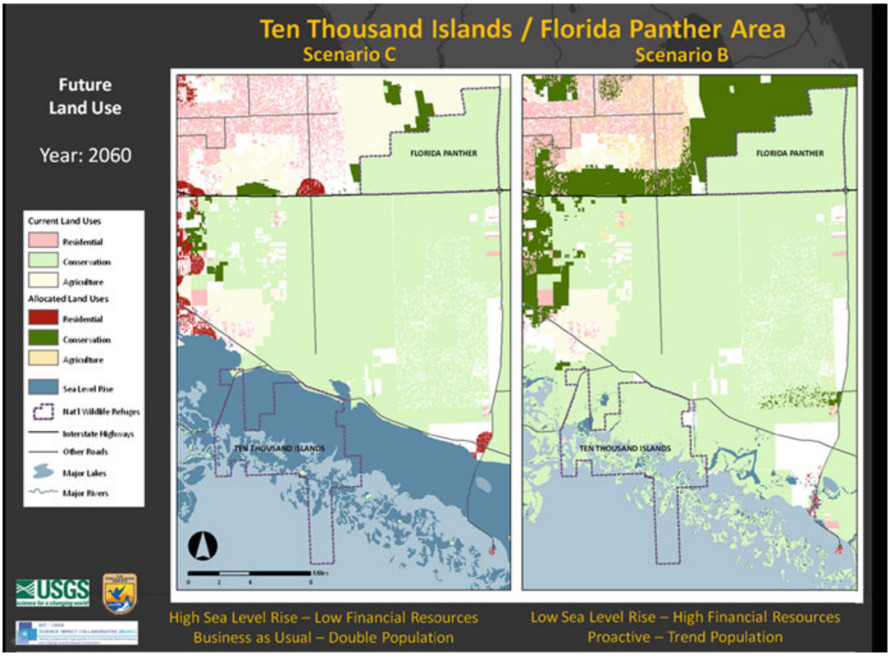
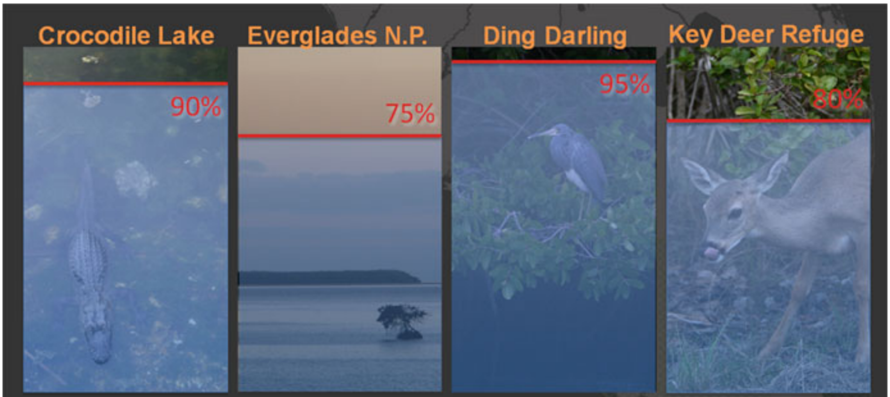


Fig. 4.6 Detail of projected sea level rise, land use and conservation change



	Sea Level Rise			
Federal Reserve	3.6″	18.4″	39.1″	113″
Caloosahatchee National Wildlife Refuge	40%	73%	100%	100%
Island Bay National Wildlife Refuge	2.5%	88%	93%	100%
Pine Island National Wildlife Refuge	5.5%	77%	82%	87%
Ten Thousand Islands NWR	8.1%	77%	96%	100%
Hobe Sound National Wildlife Refuge	6.5%	46%	70%	83%

Fig. 4.7 Percentage of key conservation areas potentially inundated by sea level rise

11 Conservation Resilience to Urbanization

The second component of conservation plan resilience is performance relative to urbanization. To assess this, we extracted urban developed areas from each scenario and spatially intersected them with conservation plans to form "conflict maps." To further characterize the conservation significance of such conflicts, we also overlaid predicted future urban growth on various environmental resource maps. For our sampling universe, we limited our consideration to those areas within the study region which have been identified under current conservation planning as priority areas, and which are not currently protected. These represent the opportunity areas for future conservation. Thus the measures of impact presented here are measures of future performance of current plans under varying exogenous conditions.

We considered several individual species as well as a broader habitat-based measure (endangered natural communities). The species considered were picked in consultation with our stakeholders to represent a range of life history characteristics and habitat requirements. The species were constrained to those for which recent published digital estimates of actual habitat we available. We utilized the most recently available revisions of the Florida State Wildlife Commission's "Potential Habitat by Species" (2009) since these had been peer reviewed and were based on a recent depiction of underlying land cover consonant with our other data. In order to represent broader-scale natural habitat types, we used two datasets from the Florida Natural Areas Inventory: "Under-Represented Natural Communities" and "Fragile Coastal Resources" (Oetting J 2010, Personal communication). In order to provide a synoptic index, all subcategories of these data sets were reclassified into a single mask, which we collectively term "Rare or Fragile Natural Communities."

In order to compactly illustrate and discuss these results, we turn again to two of the more extreme scenarios. In Scenario C, we have the highest rates of population growth and sea level rise, "business as usual" public policies and limited public financial resources. Under these conditions, urbanization would impact several hundred thousand acres of habitat. For the Scrub Jay and for rare natural communities, direct impacts from urbanization would convert almost one fifth of remaining habitat. For the Florida Panther and Caracara, potential conflicts are lower in percentage terms, but still represent tens of thousands of acres.

Under Scenario B, we have some of the best likely future conditions for conservation. Climate change and consequent sea level rise are low. Population growth is similar, but because of extensive redevelopment of transit-oriented development nodes identified by the counties, the total amount of green field development is reduced. At the same time, "proactive" land conservation policies are adopted and are supported with significant levels of public funding. In these circumstances, habitat losses due to urbanization are relatively minor, in no case exceeding 4%. This still amounts to a total of over 50,000 acres of habitat conversion in aggregate, so there is room for improvement. A drill-down analyses of these data could specify exactly which natural communities or which patches of habitat are at risk and roughly when, allowing experts in those species or areas to undertake more detailed planning (Fig. 4.8).

Conservation Element	Potential Conservation	Conflict with Scenario B		Conflict with Scenario C	
		Acres	%	Acres	%
	Area (ac)				
Black Bear	2,976,602	25,576	0.9%	385,503	13.0%
Florida Panther	1,021,181	10,080	1.0%	95,106	9.3%
Scrub Jay	108,493	3,980	3.7%	20,201	18.6%
Caracara	2,009,025	9,142	0.5%	105,060	5.2%
Rare or Fragile Natural Communities	616,794	14,495	2.4%	114,766	18.6%
Proposed Florida Greenways Corridors	1,676,713	78	0.0%	57,451	3.4%

Fig. 4.8 Conservation/urban conflict analysis

12 Overall Conservation Conflict Mapping and Plan Resilience to Urbanization

Using the development frequency classes described above, we can ask the conservation conflict question in from a land-based perspective. Of the total study region, what percentage and absolute amount of land is under highest development pressure considering all scenarios? Overall less than 7% of the total study area is at highest risk of development, amounting to roughly 540,000 ha or 1.4 million acres. A very similar fraction (8%) is at moderate risk of development (620,000 ha or 1.6 million acres were urbanized in half or less of the scenarios).

How well did the two conservation strategies perform overall relative to this range of urban pressure? To answer this question, we must consider the alternative “fates” of grid cells urbanized under one or more scenarios. For example, we can compare the “business as usual” and “proactive conservation” strategies under the assumption of high public financial “resources across” the range of climate change scenarios. In order to focus this further, we can narrow our consideration to only those lands of relatively high biodiversity conservation values. By definition, both conservation strategies were given the same budget. Which strategy worked better? There are a myriad of ways of characterizing the “better” portion of the question, since this could be asked from the point of view of any species, or habitat. It turns out that perhaps the most useful aggregate measure to look at is the difference between the high-value conservation areas which would otherwise have been urbanized.

To compute this measure, we extract those cells which were conserved under “proactive high” but which would otherwise have been urbanized (despite normal conservation practices). This area represents roughly 15,000 acres (6,000 ha) if you consider only the portions of the land of highest conservation value. Since much of these areas are on ranch and forestlands with large lots, these figures can vary considerably if the purchase of the full surrounding parcel is considered. For all such

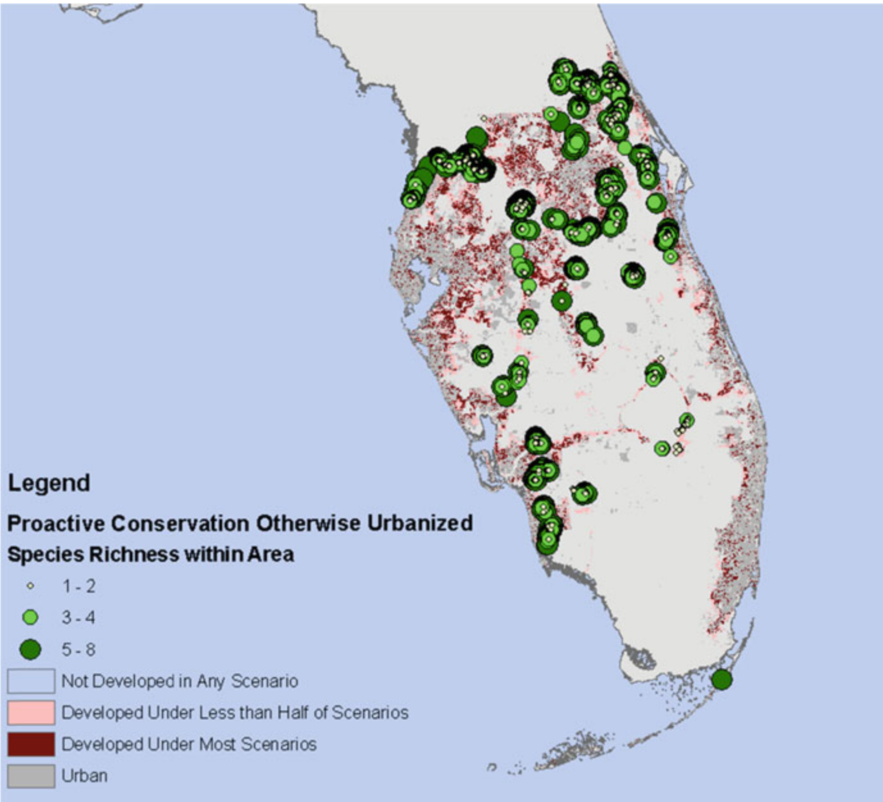


Fig. 4.9 Areas conserved under ‘Proactive’ strategy but developed under ‘Business as Usual’ (*dots* represent the predicted habitat for Florida state-listed species)

areas, the area required increases to just over 208,000 acres (82,000 ha). If only the priority portions of parcels could be purchased, their 2009 fair market value would be 65 million dollars. However, if the full parcels would require purchase, the price tag would increase to 882 million dollars. In reality, a figure between these two is most likely, especially for larger parcels.

Where are these lands? Well, they range from the Florida Keys up to the Northern boundary of the study region, but are primarily located at the fringes of existing rural residential development in the North and Northcentral portions of the study area. They form a proportionally very small, but very critical portion of Florida’s conservation future. Essentially, these are the areas which current conservation strategy misses, and which can be projected with relatively high confidence to otherwise be urbanized. With the exception of the Keys and some sites around Charlotte Harbor, most of these sites are not directly subject to sea level rise (Fig. 4.9).

A more detailed zoom into the same data provides an example of how such information might be used. For example, consider the areas outlined in white in

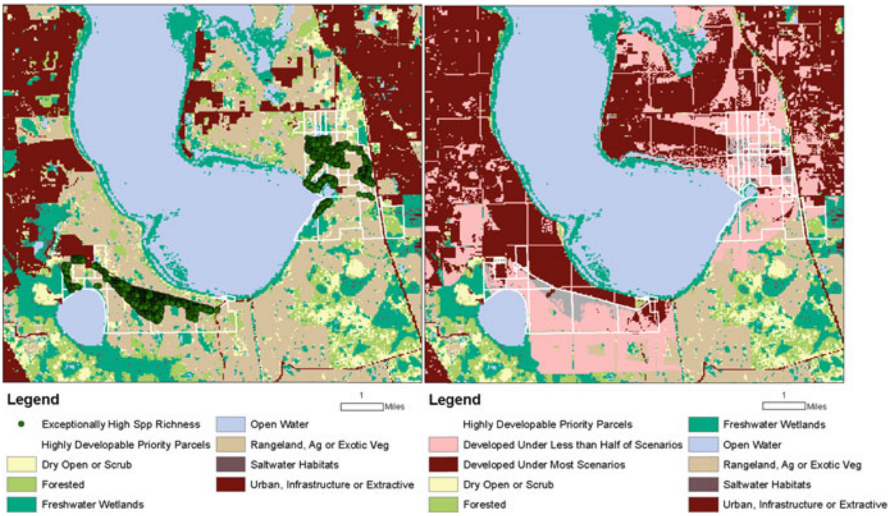


Fig. 4.10 Example of exceptionally high conservation value areas predicted to be developed under current conservation practices, but protected under "proactive" strategies

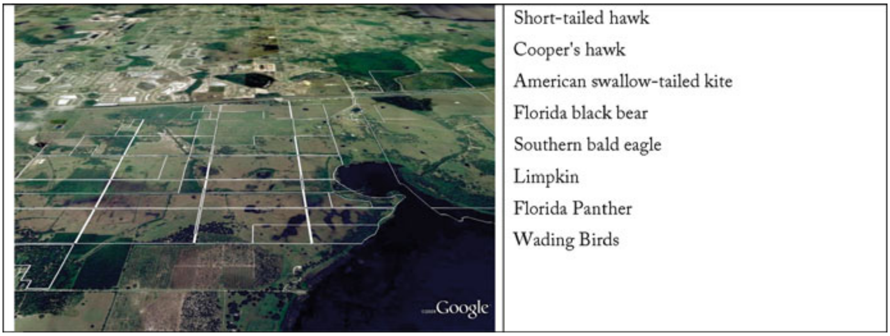


Fig. 4.11 Perspective view of parcels and predicted state-listed species habitat (Note open water, wetlands to uplands gradient and adjacent development)

Fig. 4.8. These represent 33 parcels with some of the highest species richness in the state. In particular, they contain potential habitat for seven Florida-listed species plus the general assemblage "wading birds." Our analysis shows that they would not be conserved under current strategies and budgets in time to avoid their development. From the parcels database, we can see that the land is currently ranchland, totaling 4,600 acres. It is owned largely by three people and one development company, with a current assessed value of just over 100 million dollars, or about \$22,000 per acre (Figs. 4.10 and 4.11).

13 Limitations and Caveats

While we believe the overall SRP methodology to be relatively robust given existing available input data and models, in the case of Florida several major limitations are important to acknowledge. The first is that while we have dynamically simulated sea level rise and human settlement patterns under climate change, we have not been able to incorporate dynamic models of vegetation under such changes. Similarly, because we did not have access to the underlying data sets and model logic used to create potential habitat maps, so we could only consider the direct replacement of current habitat by urban uses. It is important to note that these analyses did not consider adjacency or population fragmentation impacts which may have existed in the original models. At the time this work was conducted, essentially all of the biological resource maps and models available in this region embedded assumptions of climate stationarity.

Climate envelope and vegetation succession modeling work is currently being undertaken by other research groups in this region (Best R 2010, Ongoing climate change-related projects in the Greater Everglades, Personal communication) and its integration using the SRP method would be a very important improvement. In other regions where such work has been done, the projected spatial shifts in vegetative communities have been significant. The SRP methodology would easily accommodate such information, but the process of updating hundreds of vegetation and species models to be climate-sensitive will literally take years.

A second general set of limitations relate to terrain and hydrology. While we would like to be able to use high-resolution LIDAR-derived terrain elevation information to assess sea level rise, such information is not uniformly available across the study area. In particular subregions, we have compared LIDAR-derived terrain elevations with our USGS National Elevation Dataset data. While magnitudes differ slightly, the overall pattern described here remains.

Similarly, dynamic modeling of storm surge using models such as SLOSH (Mercado 1994) can yield a significantly more detailed picture of the risks in coastal areas. Initial indications are that such methods can yield significantly more challenging circumstances, much further inland than static coastal sea level rise methods might indicate. A more detailed investigation of sea level affects would also likely include an integrated ground and surface water model. Again, such modeling could not be incorporated because it was not uniformly available across the region.

The level of spatial modeling conducted here is indicative of vulnerabilities, and has the considerable virtue of being feasible to implement for this and most regions using only existing public data sources. With this comes the danger of underestimating complex wildlife habitat responses and hydrological issues which represent serious knowledge gaps in the literature.

14 Discussion

SRP methods vary significantly from prior work in this field in that we seek first to simulate and understand the spatial context within which conservation planning must act, and only then simulate conservation activities. We consider multiple forms of land use and land cover change, as well as sea level rise. Unlike methods which seek to optimize conservation networks in terms of biotic conservation and static land cost or urbanization pressure (Ferrier and Wintle 2009; Watts et al. 2009) we use a rule-based allocation method with fixed conservation budgets and a simple "greedy" algorithm. It is clear that application of a more elaborate conservation optimization method could yield more efficient conservation strategies for the region. However, we note that our results are more dependent on our major initial assumptions than on subtleties of conservation strategy.

Conceptually, the SRP method is very distinct from other conservation planning approaches in that it does not presuppose that conservation intent is a uniformly-held social goal. Instead, we simulate a variety of actors, some potentially acting at cross-purposes to conservation. For example, our model for high-end housing asserts that such development is attracted to the fringe of conservation areas. If real estate market demand is present and other policies or legal interventions absent, our model predicts that allocation will occur relative to "willingness to pay." To us, conservation is more similar to the game of chess than to that of solitaire – the actions of others must be considered.

Our work extends systematic conservation planning to spatially and temporally simulate two of the most severe and common threats to biodiversity: climate change and human settlement patterns. Our initial hypothesis was that both of these factors were likely to be significant influences on conservation success in South Central Florida, and their joint simulation is appropriate. Based on the high percentages of coast refuges inundated, the human population displacements simulated and the impacts of both on simple ecological indicators, we believe that our results validate this hypothesis. More broadly, we have shown that a spatial resilience planning approach can provide information not available from methods which consider only biophysical changes.

When spatial simulation is used to allocate conservation and development decisions over time, it is clear that optimal strategies must consider not only space (the eventual proposed conservation network), but also time and management institutions. Under realistic estimates of conservation budgets and land prices, the phasing of conservation purchases becomes a key component of strategy: the purchase of lands absent development pressure wastes resources better spent elsewhere, but lands under such pressure are significantly more expensive.

In our simulations, several critical aspects of human behavior are also simulated. The first is human preferences for locating various non-conservation activities on the landscape, especially various densities of housing. The second is human behavior in the face of permanent inundation. Here, we used a simple model in which all socioeconomic classes retreat equally from SLR. However, the same modeling approach could also be used to model different social responses to SLR. For example, under some scenarios, one could imagine wealthy people remaining largely along the coastline and re-enforcing existing buildings, middle income segments moving inland, and lower income groups staying in place and being at highest risk. A more positive aspect of human behavior to contemplate is generosity in supporting conservation, in the form of voluntary conservation practices. In recent years, private conservation has blossomed. For example, in the case of the Nature Conservancy, voluntary conservation easements rather than purchase agreements now account for the majority of conservation lands acquisition. This practice provides significantly more land per dollar, but also has different restrictions than conventional free simple purchases. There is a strong need to consider these aspects more carefully in future conservation simulation work.

While we unavoidably must make some important simplifying assumptions, our results nonetheless reveal some strategically significant findings. First, we find that the land area likely to be lost to sea level rise exceeds historic and current conservation budgets. This implies that only to maintain current levels of gross land under conservation management we must significantly increase the rate and the effectiveness of conservation acquisition. Second, we find that existing conservation strategies lack the temporal detail necessary to organize strategic interventions into land markets before other forces convert land to development. In particular, we show that under existing and likely resource constraints, current strategies do not maintain a cohesive conservation network likely to be robust under climate change.

The framework used here produces outputs in two forms which can be immediately incorporated into current management and planning. It produces cartographically mapped information which indicates priority areas which are sensitive and well as insensitive to varying scenario assumptions. And it generates locally-scaled strategic information on the relative effectiveness of particular conservation strategies. In other words, it produces "actionable information" in forms currently used by current institutions, but based on dynamic rather than static analyses.

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Chapter 5
Social and Cultural Incentives and Obstacles to Adaptation to Increased Coastal Flooding in East Boston, MA USA

Paul H. Kirshen, Ellen M. Douglas, Michael Paolisso, and Ashley Enrici

Abstract East Boston, Massachusetts is a coastal community in the northeastern USA that faces a growing threat from coastal storm surge flooding due to rising sea levels. Due to its relatively low income levels, large number of recent immigrants, and current environmental stresses, it is also a community suffering from environmental injustice. As complicated as adaptation to climate change may be, it is even more complicated when looking at the particularly complex situation of environmental justice. In this community it is found that the community did not have an adaptation perspective or knowledge of any resources that could assist them in this challenge. The residents also seem to have little power over the management of their community with the result that adaptation decisions may be made by processes, institutions and individuals from outside the community. All adaptation options have some disincentives for them; with high costs being common to all. Their cultural knowledge also limits their viewpoints on alternatives. Participants believe they need more information on climate change, how it will impact them, and what resources are available to assist them. Incentives for adaptation include a very broad ranging, accepting view of climate change impacts, commitment to their communities,

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eagerness to continue learning about climate change, and recognition that there is the need for an integrated regional flood management planning process that is stakeholder driven.

Keywords Climate change • Sea level rise • Coastal flooding • Environmental justice • Adaptation • Boston

1 Introduction

Presently, over 10% of the global population lives in the low elevation (less than 10 m) coastal zone (http://sedac.ciesin.columbia.edu/gpw/docs/lecz_IIED.pdf, accessed Aug 18 2010). Based upon a slightly different indicator of the coastal zone, Nicholls et al. (2007) report that approximately 33% of global population will live in coastal and low lying areas by 2080. In the US, over 50% of the US population now lives in the coastal zone and the number is projected to increase (Wilbanks et al. 2008). Most of these coastal dwellers are and will be in urban areas. Coastal communities are subject to both inland and ocean-related climate change impacts. Thus coastal communities will be subjected to climate change impacts such as rising temperatures, increased extreme and variable precipitation, and higher sea levels. The rising sea levels will cause more flooding of land during high tides and storm surges. Storm surges may also be increased by heightened intensity of coastal storms (Karl et al. 2009). The Federal Coastal Zone Management Act (16 US Code 1451(1)) states that "because global warming may result in a substantial sea-level rise with serious adverse effects in the coastal zone, coastal states must anticipate and plan for such an occurrence."

The Intergovernmental Panel on Climate Change (IPCC) provides the following definition of climate change vulnerability: "…the degree to which a system is susceptible to, and unable to cope with, adverse effects of *climate change*, including *climate variability* and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its *sensitivity*, and its adaptive capacity." (http://www.ipcc.ch/pdf/glossary/ar4-wg2.pdf, accessed July 16, 2010). Thus adaptation to reduce a region's vulnerability to climate change can be accomplished by reducing the actual climate change through mitigation and/or managing its exposure, sensitivity and adaptive capacity. Here we acknowledge the critical need for mitigation but also that adaptation to climate change must be undertaken because climate change cannot now be reversed by mitigation, only the rate of the changes can be decreased; changes will continue for centuries (Solomon et al. 2009).

Steps to manage a coastal area's exposure and sensitivity are discussed in subsequent sections. Yet, these actions are not possible without the adaptive capacity to implement them. As defined by IPCC, adaptive capacity is "The ability of a system to adjust to *climate change* (including *climate variability* and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences." (http://www.ipcc.ch/pdf/glossary/ar4-wg2.pdf, accessed July 16, 2010).

Here we examine the social and cultural incentives and obstacles to adaptation to increased coastal flooding due to sea level rise (SLR) in East Boston Massachusetts as well as some aspects of the adaptive capacity of a community. East Boston was chosen because it is already suffering from other environmental insults and is considered an “Environmental Justice (EJ)” community. Here we learn how the community’s social and cultural constraints complicate land use planning and other aspects of adaptation planning, but despite this there are also some incentives upon which to capitalize. Thus further insights are provided here on the challenges of adjustment or adaptation to climate change in an urban area. It is shown that cultural understanding is necessary for adaptation projects; a point not all scientists or decision-makers understand. Furthermore, as complicated as adaptation to climate change may be, it is even more complicated when looking at the particularly complex situation of environmental justice. Here we are providing insight on, “coordinating scientists, politicians, and people to act to restore and sustain lands.”

While the region of East Boston is subject to more climate change impacts than just SLR (Kirshen et al. 2008a), SLR is a dominant one and is the only impact considered here. In addition, due to the topography and composition of the coast line, permanent loss of land and wetlands and increased erosion are not major factors here as is the case in other regions of the US such as Chesapeake Bay and Florida. Thus only storm surge impacts are examined here.

The chapter commences with a general discussion of impacts of and adaptation planning for increased storm surges, followed by an overview of East Boston. The research process and its outcomes to understand the area’s adaptive capacity and its constraints and incentives to adaptation are then presented. Conclusions are then given on what this analysis tells us about some of the challenges and opportunities of managing for SLR adaptation in urban areas.

2 Impacts of SLR

The Intergovernmental Panel on Climate Change (IPCC 2007, page 10) states that, “Discernible human influences (due to observed increases in globally averaged temperatures very likely due to the observed increase in anthropogenic greenhouse gas concentrations) now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes and wind patterns” One of the impacts of the changing climate has been an increase in sea level because of the melting of ice on land and thermal expansion of the ocean as it is warmed (the sum of both is eustatic sea level rise, Pugh 2004). IPCC (2007) reports that the historic eustatic rate over the period 1961–2003 is 1.8 ± 0.5 mm/year with an increase to 3.1 ± 0.7 mm/year from 1993 to 2003. Sea level elevation relative to land is also related to processes that affect a specific region, including tectonic uplift and down dropping, isostatic rebound and depression, land surface changes due to compaction, dewatering, fluid extraction, and diagenetic processes. For example in coastal Boston in the northeastern United States (USA), land subsidence is estimated to have been

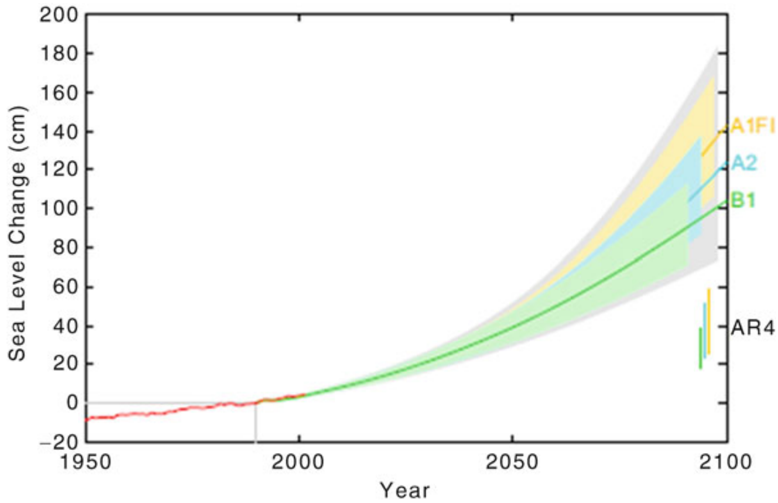

Fig. 5.1 Scenarios of eustatic sea level rise. "The colored uncertainty bands for each (SRES emission) scenario encompass 1 standard deviation (SD) from the model means of the SLR projections from multiple temperature scenarios. The additional *gray* uncertainty band shows an added 7%, representing 1 SD of the uncertainty of the (SLR-Temperature model) fit…" (Vermeer and Rahmstorf 2009, p. 4/6)

1.1 mm/year over the last approximately 100 years (Kirshen et al. 2008b). Eustatic SLR combined with land subsidence is referred to as relative SLR. The effects of SLR in the coastal zone include displacement and loss of wetlands, inundation of low-lying property, increased erosion of the shoreline, change in the extent of flood zones, changing water circulation patterns, and more salt water intrusion into groundwater.

Shown in Fig. 5.1 are possible scenarios of future eustatic SLR from Veermeer and Rahmstorf (2009) based upon a relationship between SLR and global mean temperature. There also could be regional changes in SLR due to changes in the ocean circulation. For example, Yin et al. (2009) report possible increases in future sea level in the northeastern US due to a slowing of the Atlantic meridional overturning circulation due to climate change. Coastal storm surge heights could also be increased by changes in coastal storm patterns that alter the frequency and intensity of coastal storms.

3 Adaptation for SLR

Adaptation here is defined as taking a proactive response to prepare the natural and built environments for the impacts of climate change. Compared to many other planning processes, the major challenge of adaptation planning is the consideration of uncertainties of future climates and other drivers such as population growth, land use change, and technological innovation. At its best, adaptation planning is itself a dynamic and adaptive process given the uncertainties associated with climate and other changes. An outcome of the process is actions that should be taken now and preserving the options on possible actions to be taken later. A monitoring plan is also necessary to determine when to implement options.

Most experts (Natural Resources Canada 2002; US Climate Change Science Program 2009) agree with IPCC (1990) that adaptation responses to SLR for urban areas include protection, accommodation, and retreat. Protection attempts to manage the hazard with "hard" structures such as seawalls and groins or "soft" measures such as beach nourishment. Accommodation allows human activities and the hazard to coexist through actions such as flood proofing of homes and businesses and evacuation planning. Retreat removes human activity from the hazard area which generally is accomplished by abandoning land as the sea rises. Each of these strategies has different economic, social, and environmental impacts and policy implications that are highly site dependent. Of course, there is also always the option of taking no action, but much research (e.g., Kirshen et al. 2008a; National Research Council 2010) shows that this is generally the least effective (and most costly over the long term) response in developed areas.

4 East Boston

East Boston is one of the 21 neighborhoods of the City of Boston. As shown in Fig. 5.2, East Boston is located in the northeast section of the city and is essentially a peninsula bordered by tidal portions of Chelsea Creek, the Mystic River and Boston Harbor. Large portions of East Boston were created by filling in the area between several islands during the nineteenth century. The southeastern half of East Boston is dominated by Logan International Airport. The region was originally a center of shipbuilding. It is now predominantly a residential area with some industrial and commercial activities, particularly along the coastal fringe. Buildings are a mixture of old and new. Its population is just over 50% minority. According to the Neighborhood Organization for Affordable Housing, in "East Boston, 42% of residents are foreign-born, and some 60% of these have entered the United States after 1990. The Latino community, in particular, has seen well over a 158% increase since that year. Nearly 40% of the population speaks only Spanish at home; and approximately 23% of the population is considered to be linguistically isolated. Over 20% of families in East Boston live below the poverty level." (http://www.noahcdc.org/about/index.html, accessed July 23, 2010).

Sections of East Boston are considered Environmental Justice Communities as defined by the Massachusetts Executive Office of Environmental Affairs (EOEA fact sheet; http://www.mass.gov/Eoeea/docs/eea/ej/ej_factsheet_english.pdf, accessed August 30, 2010); "neighborhoods (U.S. Census Bureau census block groups) that meet one or more of the following criteria: the median annual household

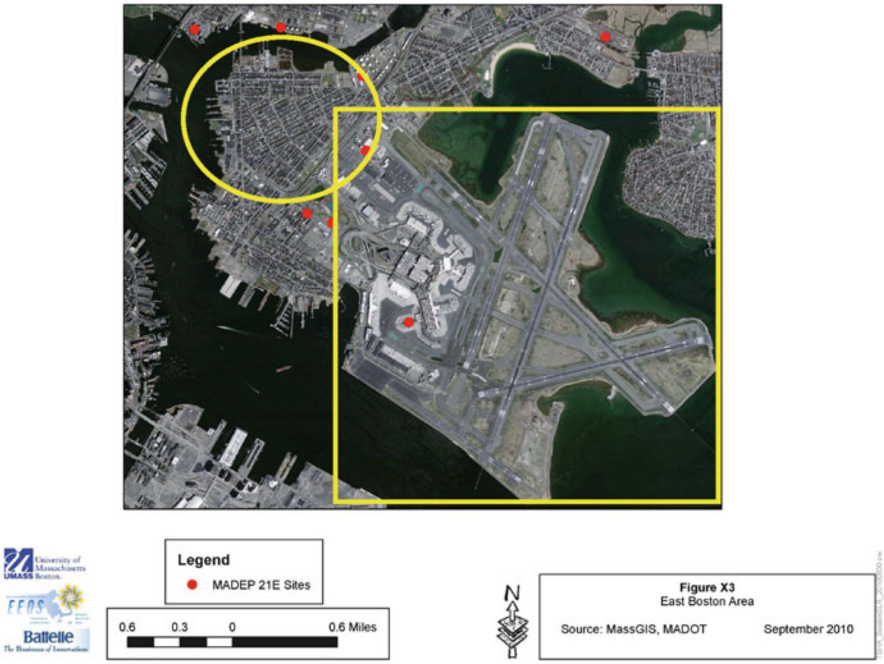

Fig. 5.2 Aerial photo of East Boston. Circle highlights the Eagle Hill community, which was the focus of our research. Square outlines Logan International Airport

income is at or below 65% of the statewide median income for Massachusetts; *or* 25% of the residents are minority; *or* 25% of the residents are foreign born, *or* 25% of the residents are lacking English language proficiency". The concept of environmental justice or EJ arose from the now well-documented observation that low-income minority communities have historically borne a disproportionate share of environmental hazards. In urban areas, low-income populations and communities of color are exposed to a disproportionate number of harmful conditions. These include:

- Toxics: in air and groundwater from past industrial practices and vehicle emissions; lead-contaminated vacant yards and lots;
- Land use: contaminated or abandoned industrial sites (brownfields); illegal dumping; vacant lots and abandoned buildings; lack or neglect of greenspace, failing infrastructure, relatively few economic opportunities, higher density housing;
- Human health problems: high rates of asthma caused by emissions especially of diesel buses and trucks, increase in air pollution, dust, noise from traffic and construction; lead poisoning, higher overall mortality and infant mortality rates, heart disease, and strokes, high blood pressure, poor access to health care, inadequate health education, fewer opportunities for safe recreation.

- Poor quality housing: older structures, contaminants in building materials.
- Inequitable access to transit services
- Community isolation or displacement.

On February 11, 1994, President Clinton issued Executive Order (EO) 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations", and an accompanying Presidential memorandum, to focus federal attention on the environmental and human health conditions in minority and low-income communities.

Our particular study area is the Eagle Hill area within East Boston (see Fig. 5.2). A large portion of this community is an EJ community and much of the East Boston coastline is a zoned as a Massachusetts Designated Port Area (DPA). According to the DPA Regulations (General Laws of Massachusetts, Chapter 91: Waterways), "the two central principles of the state's DPA policy are to promote water-dependent industries as an important sector of the state's economy and to prevent the loss of areas that have key characteristics for water-dependent industrial uses. The premise for the DPA is that it is sound public policy to maximize use of areas already suited for port areas and to avoid the conversion of these areas to incompatible residential, commercial, and recreational uses, so that future water-dependent industrial uses would not have to develop new areas for such use. …..The Chapter 91 regulations govern the licensing of structures and uses in DPAs. These regulations strictly limit the placement of fill or structures in DPAs to water-dependent industrial, accessory uses and a limited amount of supporting uses on filled tidelands". Thus some adaptation actions would have to be coordinated with MA DPA regulations. This presents both opportunities and challenges; the opportunity is that new DPA activities could include adaptation to climate change, the challenge that the community has less control over its local land use.

Due to an already hardened and elevated urban coastline, Fig. 5.3 shows that the present area vulnerable to the so-called 100-year flood as delineated by the Federal Emergency Management Area (FEMA) is relatively small in East Boston. As discussed subsequently in this paper, this vulnerable area could be significantly larger in the future due to increased coastal flooding under climate change.

5 Environmental Justice and Climate Change

Individuals trying to adapt to SLR resulting from climate change will be limited by their socioeconomic and institutional capacity (Adger 2001), which can be low in EJ communities. Thus it is particularly important to have a social and cultural understanding of these limitations in order to facilitate adaptation of these vulnerable groups.

There is now a large and growing literature focused on understanding the relationships between cultural, socioeconomic, race and ethnicity, and environmental hazards. Much of the recent literature is related to exposure to pollution emissions

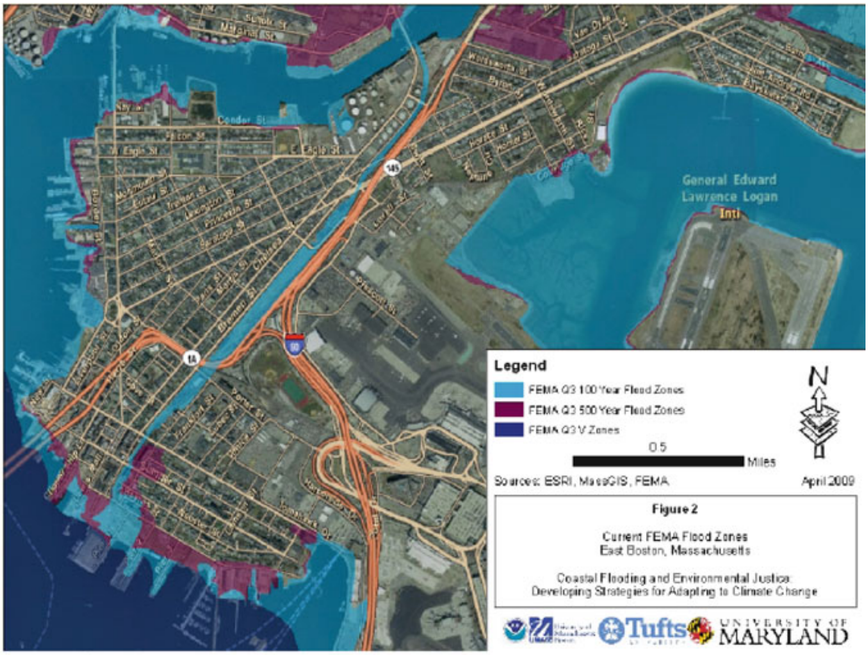

Fig. 5.3 Present 100 years FEMA floodplains

(Downey 2005, 2007; Diawara et al. 2006; Pastor et al. 2006; Krieg 2005) and public health (Resnik and Roman 2007; Lambert et al. 2006; Chess et al. 2005). Since Hurricane Katrina devastated the Gulf Coast in August 2005, a few studies have highlighted racial and economic injustices in response to natural disasters (Allen 2007; Pezzoli et al. 2007; Elliott and Pais 2006). Until very recently, little attention had been paid to challenges of EJ communities in the face of climate change, which by its very nature is a more insidious and expansive threat than that posed by present natural disasters. A report by the Congressional Black Caucus Foundation (CBCF 2004) highlighted the disparity between those who benefit from and those who bear the burden of climate change and national climate change policies. More recent research has been published by Norgaard (2006), Soskolne et al. (2007), and Ruth and Ibarraran (2009). While not directly examining the impacts of climate change, Clark et al. (1998) showed that physical vulnerability to flooding must be combined with the socio-economic vulnerabilities in coastal flood management in Revere, Massachusetts.

Environmental justice considerations will only increase as the impacts of climate change and sea level rise become more widely known and as policy and program efforts expand to build adaptive capacity. “Climate change reflects and increases social inequality in a series of ways, including who suffers most its consequences, who caused the problem, who is expected to act, and who has the resources to do so,” (Mohai et al. 2009, p. 420). The events surrounding Hurricane Katrina demonstrates how environmental inequality and environmental justice require special adaptive considerations for certain groups. The Katrina disaster exemplified the disparities among people of different racial and socioeconomic groups and how they might be affected differently by incidences of extreme weather and climate change. Of particular concern regarding the Katrina disaster are who was living in neighborhoods that were vulnerable to flooding, which groups were evacuated during the flood, how different groups were treated during the evacuation, which neighborhoods belonging to which groups were rebuilt, and who is represented in the decision making process concerning these issues surrounding Katrina and other areas vulnerable to these types of disasters in the U.S. (Mohai et al. 2009).

6 Research Methods and Analysis

The research into the community's adaptation incentives and obstacles was accomplished in three workshops with the East Boston community with an emphasis on residents from the Eagle Hill area. The workshops were organized by the authors and East Boston participants were solicited by the Neighborhood Organization for Affordable Housing (NOAH), a nongovernmental organization headquartered in East Boston. NOAH's mission is to "work with community members to improve the environment, enhance the quality of life" (http://www.noahcdc.org/cbe/index.html, accessed August 3, 2010). Generally, as requested by us, the same set of participants attended each workshop. Workshops were held in the evening, each participant was given a small payment as show of appreciation by us and to cover any local expenses, and a light supper was served. All procedures were approved by the University of Massachusetts-Boston Institutional Review Board.

Workshop One. We held the first workshop in East Boston on March 9, 2009 and was attended by 26 community residents. The goal of the first workshop to elicit the participants' cultural knowledge about climate change and impacts. By cultural knowledge, we mean the explicit and implicit beliefs and values that participants use to understand climate change. We did not want to assume that participants would understand our presentations on climate change and sea level rise impacts using our cultural knowledge. Rather, we decided that our first research priority was to try to understand their cultural knowledge, how it provided a cognitive framework for understanding climate change and from there use that information to better understand adaptation options for this community. This approach is rooted in the theories and methods of cognitive anthropology, here applied to environmental issues (Paolisso 2003, 2007).

To elicit cultural knowledge about climate change, with the longer-term research goal of linking such knowledge to adaptive capacity, we used a series of systematic data collection approaches, specifically free listing, pile sorting and multidimensional scaling (Borgatti 1996; Weller and Romney 1993). We first asked participants to freely list the words that come to mind when they think about "climate change." This was an open-ended exercise; we did not attempt to guide or direct their responses. This technique of "free listing" allowed participants to give us their ideas, and we did not place any value or judgments on their responses. A total of 74 words were mentioned and recorded on flip charts and participants were provided "post its" to mark those words that they thought represented impacts that were important to them. Again, we did not ask for any explanation, so as not to bias their cultural thinking about the terms and their importance. Next, we reduced the list of 74 words to only those that were marked as important by two or more participants. This exercise reduced the word list to 47 terms, which included a few synonyms. Finally, we asked workshop participants to organize these shared words into piles of terms ("pile sort"). Pile sorting is an easy and useful way to collecting information on similarities and differences in knowledge and values. The only instruction we provided to workshop participants was to organize the words so that words more similar to each other were in the same pile, and words more dissimilar were in different piles. Again, we did not provide any criteria for judging similarity or dissimilarity, but rather we wanted participants to use their own cultural criteria to group terms. The first workshop concluded with some general discussion of what they found interesting, difficult or confusing about the workshop exercises, what other thoughts emerged about climate change as a result of the workshop exercises, and the next steps we would be undertaking before the next workshop. Multidimensional scaling (MDS), the last step of the analysis, was to be carried out after the workshop by us for presentation at the second workshop.

Workshop Two. The second workshop in East Boston was held on April 27, 2009. There were 30 participants from the community, most of whom were at the first workshop. The purpose of this workshop was to discuss the MDS results, to present an overview of scientific understanding of climate change and to elicit participants' preliminary responses with respect to the possible adaptation options.

Between Workshops One and Two, we analyzed the pile sort data using MDS. This is a set of techniques that help researchers uncover the "hidden structure" of data by analyzing proximities within the data itself (Kruskal and Wish 1978). A proximity is a number or measure of how similar or dissimilar two objects are or perceived to be. The most important output of MDS is a spatial representation of each data point (in our case the 47 shared words representing climate change) in configurations that suggest how similar or dissimilar the data are to each other (Kruskal and Wish 1978). Visually, the more similar two data are to each other, the closer they will be represented in the spatial representation, and the opposite is also true: in the case of our climate change words, the farther apart two words are in the spatial plotting, the more dissimilar workshop participants thought the words were. MDS programs plot proximity data in "n" dimensions, though most researchers analyze data using either two or three dimensions. In interpreting the MDS spatial representation, the researcher, with assistance from workshop participants in our case (see below), can focus on two specific analyses: (1) identification and evaluation of the meaning associated with close clusters of data (e.g., words about climate

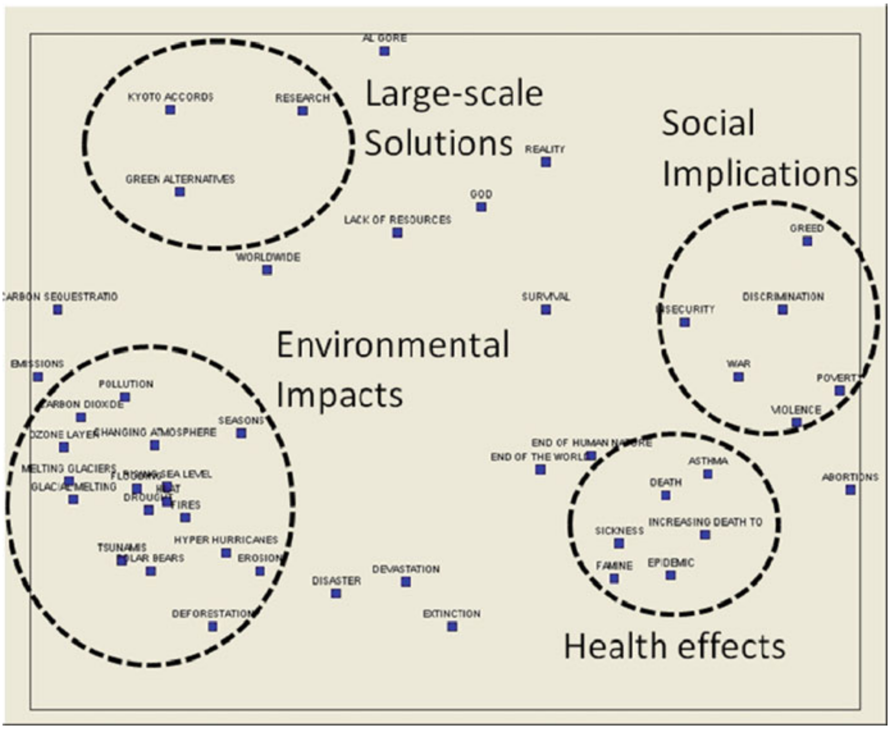

Fig. 5.4 Multidimensional scaling of pile sorting exercise from first East Boston workshop

change) and (2) exploration of possible explanations for the overall distribution of data in order to identify the hidden dimensions underlying/organizing the data. We describe our application of these two analyses below. The results presented below were generated using non-metric multidimensional scaling tools of the software program Anthropac V4.0 (Borgatti 1996).

At the beginning of Workshop Two, we reviewed what the participants had accomplished in the first workshop, and then showed them the MDS results, minus the circles and labels on Fig. 5.4. From our discussion with the participants, which included much probing to help them articulate some of their rationale and thoughts about why particular words were either close together or not, we have identified a number of possible patterns in the MDS data that suggest meaningful and relevant cultural knowledge and values about climate change. First, as indicated by the circles in Fig. 5.4, we have identified four categories or groupings of the data that we hypothesize represent broader categories of cultural knowledge about climate change. We have labeled these categories as: impacts on the environment (i.e., pollution, carbon dioxide, polar bears, glacier), effects on human well-being (asthma, epidemics, death), social implications (greed, discrimination, war) and large-scale solutions (Kyoto accord, research, green alternatives). There was also possible smaller grouping of words such as disaster, devastation and extinction. Again, the closer the words, the more participants considered the words closely related, and vice versa.

Focusing on these four categories of climate change, the MDS results are also noteworthy in that there are many words for environmental impacts, compared to the words for the other categories, suggesting that when thinking about climate change, participants are often thinking about impacts. It is also interesting that the words associated with social implications could be interpreted as social causes, and that regardless of whether these are implications or causes, they are broadly and generally defined. The health effects are tightly clustered, suggesting that respondents tended to see health words as associated with each other, rather than with a particular type of environmental impact. Of the circled grouping of terms, the large-scale solutions is perhaps the most dispersed, in terms of word proximity, and in fact could include terms from outside the presently-drawn circle, such as the word "Al Gore."

Finally, it needs to be emphasized that grouping words into clusters and labeling them is an interpretive activity, that other clusters could be drawn and labeled slightly differently. However, regardless of the specific cluster analysis and labeling, such interpretive analyzes must be reasonable according to the proximity distances and patterns in the overall MDS results. We are confident that others interpreting this MDS plot would identify a grouping of terms that we would all recognize, broadly, as impacts, though we might label the grouping differently and even focus on different subgroupings within these clusters, depending on our research interests.

In reviewing the MDS results, it is important to also focus on data that appear to be not very similar to other data, words about climate in our case. What may be the most striking finding from the pile sorting and MDS analysis is the absence of words that describe adaptation or capacity to adapt. In our workshop discussions with participants, and in follow up interviews, we discovered a rudimentary awareness of mitigation strategies (mostly related to energy efficiency and emissions reduction) but did not find much existing cultural knowledge adapting to the impacts of climate change. From these discussions and in part based on our own reflections, we offer some possible reasons for the absence of words that suggest a shared cultural knowledge about how to adapt. First, it may very well be the case that workshop participants do not believe that there are solutions or adaptations to many of the environmental impacts they mentioned. Some of the impacts (e.g., deforestation, drought, fire, erosion) they may know about first hand, having experienced some of them in rural or urban areas in Latin American before migrating to the United States and East Boston; other impacts (e.g., polar bear [decline], ozone layer [depletion] and sea level rise) they may have heard or read about, but do not have any first-hand experience with. Thus, for both types of impacts, they may not have had cultural experiences of efforts to adapt to such impacts, either because of lack of resources in their home countries or because of lack of direct experience or relevance. Therefore, we perhaps should not expect them to conceptualize or talk about adaptation, or have existing cultural knowledge that would predispose them to knowing or valuing adaptation. However, it is important to emphasize here again that workshop participants did not report with any degree of frequency terms/information that indicated an understanding that there are means to adapt and there may be some local, state and federal programs that can help them address issues related to climate change.

The second part of the workshop was devoted to explaining the major causes of climate change, particularly how scientists know what the past climate looked like from ice core data and how we assess what future climate could look like from modeling various CO_2 emissions scenarios. We also presented selected results from the Northeast Climate Impacts Assessment (Frumhoff et al. 2007) to highlight observed and projected local climate change impacts. We then presented maps that showed the extent of 100 years floodplain for East Boston in 2030 and 2100 for low CO_2 emissions (IPCC SRES B1) and high CO_2 emissions (IPCC SRES A1fi) scenarios. We did not dwell on other possible significant climate change impacts such as drainage problems and heat stress (due to research budget constraints), although these were of concern to the participants. Integration with these impacts will to be carried out in later research.

In developing the floodplain maps, we followed the method presented by Kirshen et al. (2008b) for several tide conditions. Historical land subsidence rate and 100 years storm surge height from Kirshen et al. (2008b), SLR estimates from Rahmsdorf (2007), and additional SLR in 2100 along the Northeast US coastline due to a potential slowing of the ocean circulation in the North Atlantic from Yin et al. (2009) were combined. As can be seen by comparing some of the possible future floodplains to the present 100 years FEMA floodplain in Fig. 5.5a, b, c, there are substantial increases in floodplain extent, but the extent of flooding is highly dependent on when the storm occurs within the tidal cycle. Originally, we were going to present only the results at mean higher high water (MHHW) to be consistent with our previous maps (Frumhoff et al. 2007; Kirshen et al. 2008b). However, our NOAH collaborator had grave concerns about the alarm that could be caused amongst the residents by just presenting this scenario. As a result, we presented the 100-year flood plain extent assuming the storm occurred at mid-tide (Fig. 5.5a), high tide (Fig. 5.5b) and presented the 100-year floodplain extent at MHHW (Fig. 5.5c) as the "worst case scenario" that we hope to avoid.

After we presented the flood maps, we began a discussion about options for adaptation to increased flooding due to climate change. We first presented the four categories of flood protection: protection, accommodation through floodproofing and evacuation planning and retreat. East Boston residents reacted very strongly against coastal hardening and retreat. They stated that there are many negative aspects of living in East Boston (traffic congestion, access, nearby Logan Airport), but one of the few positive aspects of East Boston is access to water and a sea wall conjured up visions of a high concrete barrier that would completely block water views. Resident's first question about evacuation was whether other low lying areas close by would also be flooded. When they learned that the entire region would be under flood, they stated they had no place to go. Friends and family were mostly in East Boston and few, if any, participants had the resources to stay in a hotel room on higher ground for any

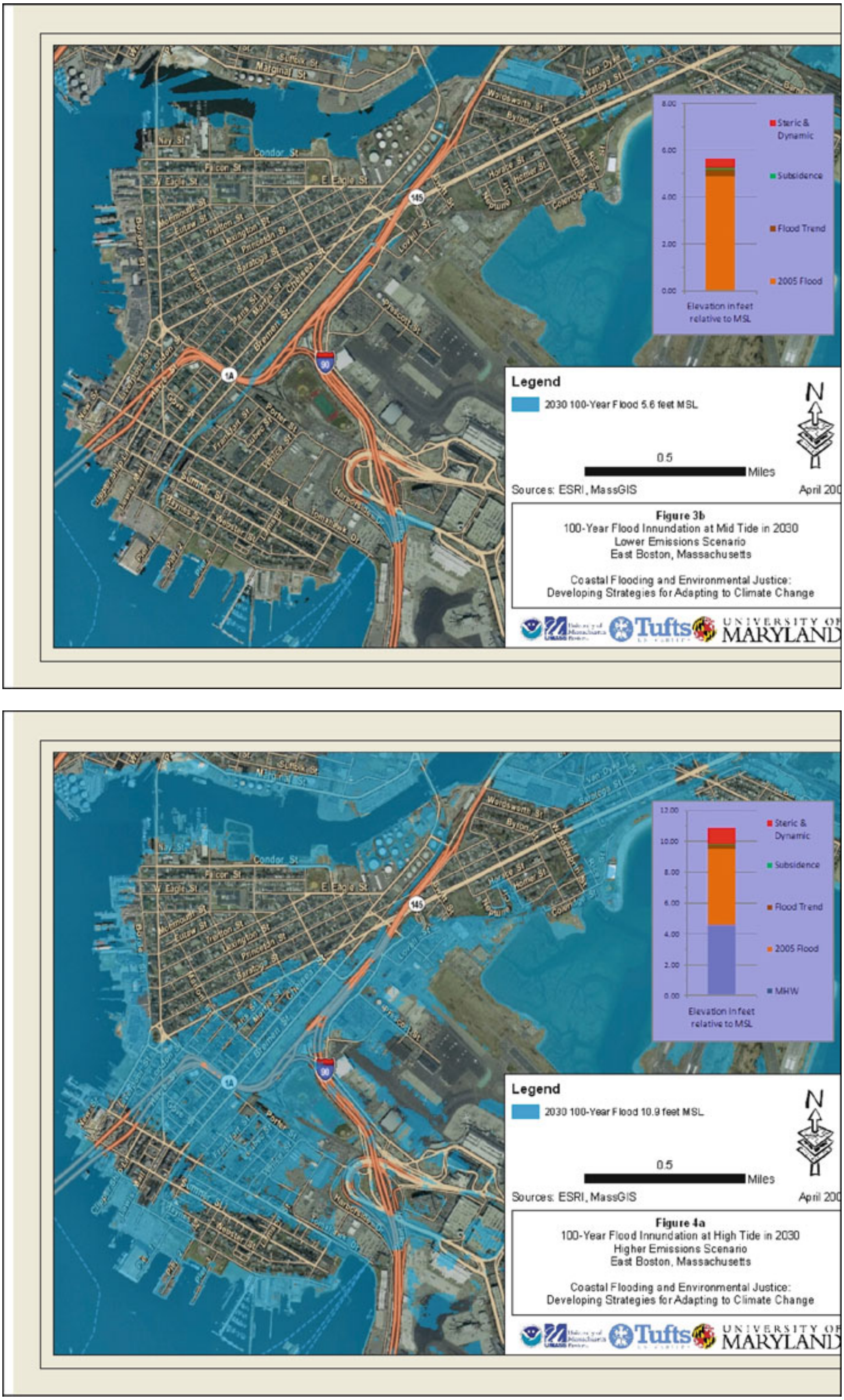

Fig. 5.5 (**a**) Extent of 100-year coastal flood at mid-tide in 2030. (**b**) Extent of flooding due to 100-year coastal flood at high tide in 2030. (**c**) Extent of flooding due to the 100-year coastal storm at mean higher high water by the year 2100, under the higher emissions scenario. This represented our "worst-case" scenario

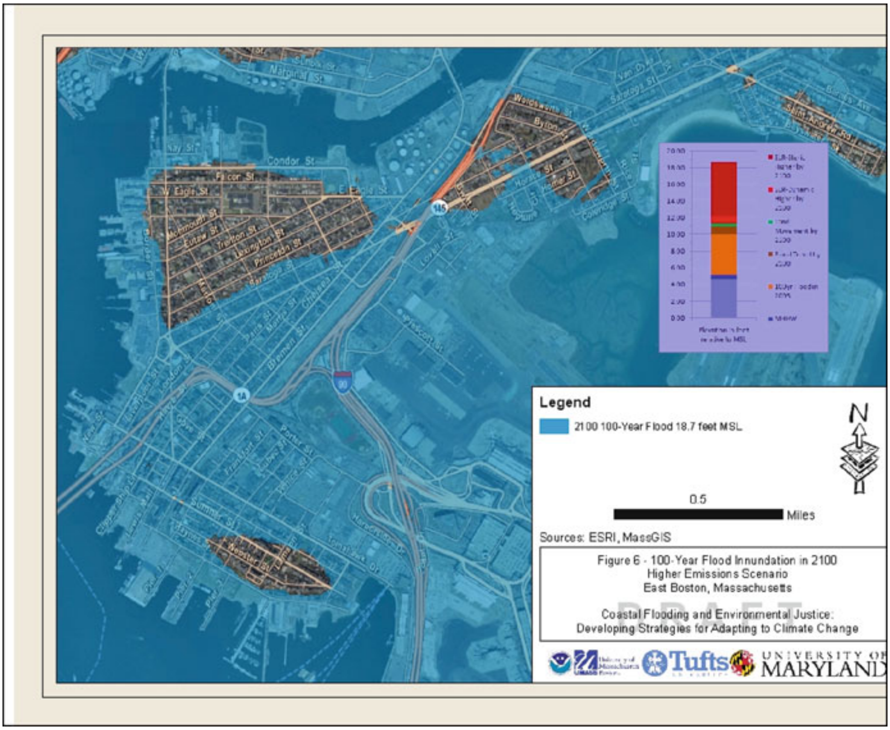

Fig. 5.5 (continued)

length of time. Flood proofing was not really an option as few owned their residences and landlords would be reluctant to give up first floor rental income. Retreat was simply out of the question; East Boston was their home and no one was willing to consider leaving the area because of an increased risk of flooding. The biggest concern overall was one of money: who was going to pay for the adaption? Were governmental agencies willing to help them cope with the potential impacts of increasing coastal flooding due to sea level rise and where the funding would come from? These concerns were explored in a more structured manner in the next workshop.

Workshop Three. About a week before the third workshop, we surveyed a few key informants within East Boston community to obtain an understanding of how individuals viewed climate change and adaptation and the results from the second workshop. Below are a few observations from these surveys:

- Understanding of climate change: two of the three interviewees were very involved in environmental issues within the community and aware of climate change in general. The other was not; he stated that he was taking our word for it. This supported the objectives from our first workshop, which was to first get an understanding of the participants' views on climate change before proceeding.
- Seawall: the concept of a sea wall presented in workshop two turned out to be very controversial, but we found that was in large part due to the image that was

conjured up in the participants' minds. When presented with a modular sea wall design which could be increased in height as the sea level rose and was much more aesthetically pleasing than they anticipated, one interviewee noted that it was "cute". So having a realistic image of proposed strategies is key to acceptance of these strategies.

- Evacuation: a huge concern with respect to evacuation was leaving valuables behind and the risk of theft. Also, at least one of the interviewees noted the option of just heading to higher ground in an adjacent community, which indicated a lack of understanding as to the scope of the flooding issue.
- Outside influences: the airport was mentioned by all three interviewees and appeared to be viewed by residents as a common "enemy"; that it was taking over East Boston. Hence, it would be important to address the role of the airport and also try to make them a community partner rather than an adversary.

Although we would have liked to have been able to perform more individual interviews, the information gained from these three key informants was very valuable in setting up our presentation for Workshop Three. In addition, we were able to compare individual responses to the workshop responses, and found that there was general agreement.

The third workshop, held on March 29, 2010, focused on community incentives and obstacles to various adaptation options that we presented to them, since they were not familiar with adaptation possibilities. To focus the discussion, we presented conceptual images of some options which were designed to be flexible so they could be adjusted to SLR changes over time. These included a modular sea wall, building a beach and dune system to protect a presently exposed coastal area, the building up of a present beach with geotubes to provide additional flood protection and various types of wet and dry floodproofing. The beach concepts also provided amenities now as well as protection later. We also presented the present City of Boston emergency evacuation plan for East Boston. The plan locates roads exiting East Boston designated for evacuation, locates shelters and gathering sites within the Eagle Hill area, and describes procedures for evacuation planning and action. The plans are designed for multiple hazards, not specifically designed for flood emergencies. These plans were depicted and discussed. Our mapping exercise indicated that portions of many of the evacuation routes and some of the shelters could be flooded by a 100-year storm surge in 2030. Serendipitously, on the night of the workshop, we were experiencing the third of three large rainstorms to hit New England in March 2010, so flooding issues were foremost on everyone's minds.

After the presentation of options, the participants were divided into four groups with a moderator to discuss the following questions.

1. Which of the adaptation options seems most feasible/attractive ?
2. Which options would you object to and why?
3. What obstacles are in the way to getting the options in place?
4. What needs to happen to make adaptation a reality?

Results are below by question.

6.1 Which of the Adaptation Options Seems Most Feasible/ Attractive?

Generally, most supported the concepts of utilizing natural approaches as much as possible. This would include beach systems as well as wetlands. The advantage is the flood protection combined with neighborhood amenities. If some type of protection system has to used, the natural-based materials such as sand or geotubes are more attractive than hard walls. Overall, there was more acceptance of the modular sea wall as an option in some places, which was a very different reaction than during the second workshop. This attests to the power of images in conveying an idea.

Some supported the concepts of floodproofing by wet and dry methods as appropriate. Very few supported elevation of existing buildings. Only a few supported evacuation as an option. Some suggested using the facilities at the nearby Logan Airport as an evacuation site; tour boats such as "Duck" boats could be used to ferry residents if necessary. Part of the airport terminals are relatively high and they have food preparation and water and toilet facilities.

Others brought up the concept of connecting the chain of islands in the harbor with an opening hurricane barrier.

A number recognized that it may be possible to implement some adaptation measures against coastal flooding that also protect against other climate change threats such as increased local drainage flooding from more intense rainstorms.

There was some discussion prompted by one of the facilitators about when the group recommends action be taken? Do you think it makes sense to do it now or wait?

Some remarked that actions should be taken now to avoid a situation like the flooding during Hurricane Katrina. Others were willing to wait until had more information but agreed with the facilitator that options for future actions need to be preserved now.

All agreed that community members need to be a part of the planning process.

6.2 Which Options Would You Object to and Why?

Every option had some objections. Protection based upon sand systems face the threat of loss of stability and erosion. Sea walls are generally unattractive and block views (though there was some discussion of the trade-offs of views and safety). How does water behind sea walls drain out? Dry flood proofing with tarps around the basement might be difficult to implement. Elevation of some buildings would be unattractive and difficult because so many buildings are attached to each other. There are also many basement apartments making any kind of flood proofing difficult. In addition, since many rented their residents, they would not be able to carry out these options. Evacuation was a concern because of the resulting traffic jams, the costs of staying outside of their residence for any period of time, most residents not having cars, and a significant number of disabled and elderly people. Many people would stay to protect their property. Permanent retreat is not seen as an option because of desires of residents to remain close to family and friends and general difficulty of obtaining low priced housing; "permanent moving should not be on the table… People in East Boston have a real identity and roots… there needs to be a better plan for staying here."

Some acknowledged that living close to the coast presented a special set of risks that must be recognized.

6.3 What Obstacles Are in the Way to Getting the Options in Place?

All the workshop participants mentioned that cost was a major obstacle for the community taking action. Costs for individuals would be high and landlords would be unwilling to invest in floodproofing rental units because of possible lost of rents from lower units.

Other obstacles to evacuation besides the previously described ones include some having no place to go – no family or friends within ten miles inland. Evacuation preparation time of 24 h would also be an obstacle. Another obstacle was the need to redefine the evacuation routes after the next few decades so they would be passable – if that was possible.

Other obstacles included the need to coordinate flood protection from multiple sources – for examples from areas outside of the neighborhood and the drainage network also backing up – both possibly negating any local adaptation defenses. Participants also mentioned that dealing with the local municipal bureaucracy was very difficult. Interestingly no one mentioned current floodplain management policies of the City, the state, and the federal government. Also, no one mentioned that much of the neighborhood coastline is a Designated Port Area.

6.4 What Needs to Happen to Make Adaptation a Reality?

Some suggested that the City of Boston fund and build large protection projects that protect many residents because many homeowners and landloads will not will pay to take steps to protect individual residences. Perhaps also all new buildings should be floodproofed and zoning has to be improved.

Most participants agreed with the suggestion of one of them that one of the first actions has to be for all to recognize the challenges of climate change and then for the community to participate in the planning process – "So they don't feel powerless". Several factors were seen as important to accomplishing this. There is the need to educate a broad range of stakeholders. More information on climate change is key.

Community groups need to become more involved by helping negotiate between the City and the community, between landlords and renters. Participants offered to go out and each talk to two to three people about climate change in East Boston. The goal is for "people (to) get concerned and start taking prevention measures."

7 Summary and Conclusions

The findings above indicate there exists a myriad of social and cultural obstacles to adaptation in this community that limits its adaptive capacity.

The MDS analysis indicated that the community did not have an adaptation perspective or knowledge of any resources that could assist them in this challenge. In fact, the MDS results suggest the possible belief that any humans or societies could not adapt to problems of this scale. This presents an opportunity for future work to explore if educating residents about climate change and options is key to empowering them to act on their own behalf. A further line of research inquiry is that perhaps this is common for recent immigrant groups that have a tradition, present or in their past, of being dependent on nature and subject to unmanageable natural disasters such as floods, storms, and earthquakes. Religious values should also be further explored (the word "God" was marked as important but was not associated consistently with any other climate change term in the pile sort exercise).

In addition to cultural knowledge factors, there are obvious economic and political constraints that negatively impact on residents' adaptive capacity.

- The residents seem to have little power over the management of their community. They are generally renters with very limited economic, political or social resources. It appears that the adaptation decisions will be made by processes, institutions and individuals who are between these community members and the climate change impacts, e.g., the Designated Port Area of the City of Boston and other city agencies, and landlords.
- All options have some disincentives for them; with high costs being common to all. Permanently leaving the area is the least attractive. Even though most of them are recent immigrants, they have strong ties to each other and to the concept of remaining together in East Boston. Their cultural knowledge may limit their viewpoints on alternative locations or communities to live in.
- Participants believe they need more information on climate change, how it will impact them, and what resources are available to assist them. Thus even though there have been many reports on climate change and the need for local participation in adaptation (e.g., NRC 2010; Karl et al. 2009), this information has not reached this community or yet resulted in locally driven adaptation planning.

On the other hand the research uncovered many incentives to pursue adaptation planning with this community.

- They have a very broad ranging view of climate change impacts, as evidenced by the free list, pile sorts and MDS results. They do not appear to be climate change naysayers. Their very holistic view of possible climate change impacts, while not science-based, is a good platform for further education and learning about the multiple connections between climate change and a range of impacts.

- They are committed to their communities, out of choice and also a lack of other housing options; they don't want to leave; it appears that they want to stay. They also recognize coastal living presents special risks.
- While initially the participants had no or a limited concept of adaptation, at the end of the process they were eager to continue learning about climate change and recognized that there is the need for an integrated regional flood management strategy.
- Participants prefer options that enhance their present environment and will not require evacuation or permanently leaving the area. Further research into the social, economic and environmental aspects of various kinds of adaptation options is necessary to determine if it is possible to meet this preference and if not possible in all cases, then other acceptable options must be found.
- The participants realize that stakeholder driven solutions are necessary, and are eager to collect more information on climate change and organize to engage any available institutions and resources to help them. At the end of the workshops they seemed less powerless than during the first workshop and wanted to take action. In other words, this community, while not in main stream of the decision making process, once they become educated and engaged in this issue, are willing and able to become a part of the decision making process. The research team is presently working with NOAH to find resources to help in the next steps of adaptation planning.

Understanding existing cultural knowledge and values about adaptation to climate change must be part of the framework for adaptation planning. Given the community's desire to move forward with adaptation and the present lack of local active engagement by government on adaptation here, we believe that a collaborative planning and learning process such as Joint Fact Finding (JFF) with local and institutional stakeholders is the next step for East Boston. In JFF, "stakeholders with differing viewpoints and interests work together (with the technical team) to develop data and information, analyze facts and forecasts, develop common assumptions and informed opinion, and, finally, use the information they have developed to reach decisions together" (Ehrmann and Stinson 1999, p. 376).

We looked at a segment of a community that has a history of being an arrival place for immigrants. Under the present institutional and social conditions, a possible scenario is that only the landlords and port businesses would be the end-users of adaptation support, not the immigrants. Thus the present immigrant residents might be forced to leave after suffering severe flood losses, only to be replaced by other poor immigrants. Certainly, if flooding resulted in a cycling through of new immigrant residents, then we truly have another environmental justice issue for this community. We believe this can be avoided if the incentives for adaptation planning in East Boston are implemented. This can only be understood by the social and cultural analysis undertaken here.

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Chapter 6
Collaborative Modelling as a Boundary Institution to Handle Institutional Complexities in Water Management

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Keywords Collaborative modelling • Agent based modelling • Boundary objects • Boundary institution • Water management • Participatory processes

Water management is an area for several sources of institutional complexity, which have been extensively studied but are still poorly handled in practice. In this chapter we add to the family of boundary entities a concept of boundary institution, in order to re-visit the dynamics at stake in participatory modelling. On the basis of a few case studies, we show that participatory modelling, as a process, fits this concept of "boundary institution". A boundary institution is a step above considering the model as a boundary object, because it provides rules for interaction among stakeholders without prior consensus among them. In addition, these institutions provide prototypes to develop other institutions that address complex water management issues or that could help in providing institutional infrastructure (rules, etc.) to existing boundary organizations. Boundary institutions have no tangible infrastructure.

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Because they are intangible, how boundary organizations actually function will require further research.

1 Introduction

Collaborative modelling, which involves stakeholders in simulation and modelling processes, has an increasing place in research, planning or management. This is particularly true when dealing with environmental issues such as natural resources management. For example the Environmental Modelling & Software journal has recently dedicated a special issue to collaborative modelling with 15 different case studies and review papers (Bousquet and Voinov 2010). The field is very active and is populated with various "schools" gathering specific tools and protocols in stakeholder involvement (Voinov and Bousquet 2010).

Many reasons exist to justify involving stakeholders in modelling (Barreteau et al. in press). One is grounded in the assumption that it is a way to handle institutional complexities present in environmental management and planning. Early works of Schelling (1961) have made the point that settings generating interactions entail representing some complexity. Simulation and gaming situations, as well as collaborative modelling, handle institutional complexities and interactions, by generating a decision process distributed across participants or players causing them to interact. Participants or players react to a situation not only according to specific rules set by the model of simulation but also based on their individual experience and knowledge. In so doing, they generate a new situation to which they react and so forth and so on (Barreteau et al. 2007).

Collaborative modelling facilitates adaptation in a changing environment. This expectation is grounded in postnormal (Funtowicz and Ravetz 1993) and social learning theories (Webler et al. 1995): involvement of stakeholders in modelling makes more open and explicit the decision processes using these models, and it enlarges knowledge of participants, which they can use on their own.

A collaborative modelling process results in a model, which informs on institutional complexity, the arenas and dynamics it encapsulates. We consider it in this paper only as it is fed back towards participants involved in these arenas.

Specifically, we describe how collaborative modelling works as a "boundary institution" (e.g., generates new arenas) using a set of case studies dealing with water management. The first section explains the specific institutional complexities at stake with water management and introduces key features of concepts of boundary objects (and their inheritance) in relation with this institutional complexity of water management. The second section describes collaborative modelling with its diverse kinds of implementation and specifies what we mean by a boundary institution. Next we describe four case studies of water management where collaborative modelling has been used with a focus on the changes induced and the interactions at stake. The last section synthesizes the various interactions facilitated by these case studies of collaborative modelling to better shape its role as a boundary institution.

2 Water Management System as a Specific Case of Institutional Complexities

2.1 Institutional Complexities in Water Management

Many books and papers describe the complexity of the management of resources (Pahl-Wostl et al. 2007; Cowie and Borret 2005). We describe it here along three levels: multiple uses of water, territorial issues, and interdependence with other institutions and networks.

As pointed out by Cowie and Borret, water management complexity is technical as well as institutional. Water management deals with various types of goods, water itself, resources included in water (fish, etc.), and services provided by water (energy, recreational activities, etc.). All these goods and services are handled in various institutional frameworks. Integrated water resources management aims at providing the frame to handle the interactions among these various institutions. In France for example, ad hoc committees at the county level handle drought situations. According to water uses in a specific county, such committees will gather farmer representatives, the electricity company representatives, fishermen representatives, and all the local and national administrations in charge or supervising these uses. These committees have to find out ways to agree on actions to mitigate drought situations with their heterogeneous stakes and ways to assess the situation.

The second dimension of institutional complexity is territorial. Water flows across borders, and its use generates externalities. Dams upstream of borders that may limit water downstream, pollution generated on one side of a border that impacts the other side, and propagation of flood risk are common issues, which can generate conflict among different jurisdictions. The multiple institutions involved often do not have venues to build consensus for formulating cross-jurisdictional policy and managing water resources. Ad hoc organisations for large international rivers (such as for Rhine, Rhone or Danube rivers) have emerged but lack real political power and not effective for coordinating actions across international boundaries. River basin management organisations or water bodies as they are defined in the EU Water Framework Directive constitute an attempt to provide these arenas at a more local scale. They aim at focusing on water issues and at overcoming limits due to administrative boundaries. This development of entities with power to rule water within a hydrologically coherent area aims at providing arenas to handle water related externalities across institutional boundaries. State boundaries are obviously a major issue but they are not the only ones, as this institutional complexity occurs as soon as hydrological systems cross any jurisdictional boundary. However, whatever the scale, these organisations are still weak, as they are constituted by representatives of the political organisations managing the political territories that cross the hydrologically coherent area and provide the financial means they need. Non-physical flows of water—the concept of virtual water, blue and green water—cross jurisdictional borders as well (Ridoutt and Pfister 2010). The water needed to produce a material good, with its relative scarcity at the production place, is not taken in to account by any institution, but by the market where the transactions on the good take place.

A third source of institutional complexity comes with interactions between water management institutions and other institutions, including land management and development institutions and social networks (such as kinships, ethnic groups, etc.). In many places, water management is first an issue of land management and power to control one's own development. Water is a key resource that needs to be taken into account for future land development: quality and quantity of water as well as regulations to protect these constrain development. For example from the point of view of a city, the quality of water distributed to its inhabitants is important. To ensure water quality, cities may seek to control the land use around the sources of their potable water, even if they do not have sufficient funds to purchase the land control (Salles et al. 2006). On the other hand, such as in Northeast France, the main concern for mayors with new boreholes in the area of their commune is not the resource which might be lost, but the constraints generated on land uses around this borehole, which freezes a part of their development capacity.

Last but not least, water management and water use are issues of people. Therefore all the existing social boundaries could generate conflict over the use of water resources. For example, tensions between ethnic groups in Northern Thailand (Promburon 2010) and conflict involving access to external aid in the Senegal river valley (Barreteau 2003) interact with water management and the capacity to find solutions for joint management across these boundaries.[1]

Finding the relevant organization to deal with this institutional complexity is illusory as no such current institutions exist: changes in water and land use or social dynamics will keep new interactions occurring and new institutions must be developed that make decisions in the face of ongoing change (Chap. 22). Thus, we must find a way to deal with interactions across orphan boundaries, those for which there are no institutions to handle interactions across them, and to craft institutional arrangements to make these interactions possible with a minimum of pre-conditions on any agreement between counterparts.

2.2 Boundary Entities Embedded in a Dynamic Process

"Boundary work", "boundary objects", "boundary organizations"[2] and other "boundary" entities have been developed in the field of Science and Technology Studies to work on the interactions between science & policy on the follow up of Star & Griesemer's seminal work (Star and Griesemer 1989; Hoppe 2010).

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[1] See Chap. 19 for a discussion of the importance of social and cultural boundaries.

[2] See Chap. 10 for a discussion of boundary organizations.

Star (2010) defines boundary objects as support for agreements within groups without any prior consensus. She insists on the three following main features:

- interpretative flexibility allowing understanding and action in various social groups,
- a material and organisational infrastructure made of norms, categorisations, standards,
- a suitable scale, which is the organisation.

In addition, Star describes boundary objects as parts of a dynamic process (Star 2010): a boundary object appears between several social groups, where it is ill-structured. If suitable to their needs, some groups work on its basis, crafting it so that it becomes suitable to their own world, out of the interaction with other groups. Then it comes back as a shared entity in-between the groups and it keeps alternating between these two formats: ill structured and shared, crafted to one use. When this dynamic stabilizes, the boundary object has evolved in an institutionalized infrastructure to facilitate the interaction between entities. New boundary objects may develop to facilitate interaction that does not fit in the new infrastructure.

Institutional complexity characterized by water management presents several levels, scales, or interfaces as listed in the first section. Even though some of these interfaces, where various views may be expressed or various groups may join, are accommodated by specific boundary organizations such as water agencies in France or South Africa, some boundaries are still orphan and some of these boundary organizations are empty shells in practice and unused. There is a need to provide infrastructure for facilitating interactions at the interfaces between the various institutions concerned with water.

The concept and use of boundary entities fulfils the need to deal with orphan boundaries of water management. They generate material and non material devices to facilitate interactions but do not need any prior consensus on a given format. These devices have their own rules and equipment regarding their access and use.

We ground our concept of "boundary institutions" on the concept of boundary entities and on institutional analysis and design as developed by Ostrom (Ostrom 2005). We consider a boundary institution as a set of rules in use (1) governing the joint arenas where various concerned groups can meet, and (2) providing a bridge between previously established institutions indirectly connected through water. As such they are a kind of oxymoron, since they need to be repetitive enough to be used as rules, and flexible enough to leave space for interpretation in various groups. They require having a minimal common understanding on their meaning on both sides and being acceptable within various groups. Under these conditions, they facilitate the articulation between various participants of the interface, like boundary objects, and other boundary entities. Such boundary institutions allow, for example, exchange of viewpoints on a water system or joint assessment of a drought situation with different sets of indicators and benchmarks (Barbier et al. 2010).

Models have already been presented as good candidates for boundary organizations (BO) (Trompette and Vinck 2009; Etienne 2010), and they are useful tools in many aspects of water management, we will look at collaborative modelling as a "boundary institution" in the middle of institutional complexities of water management. The next section describes what collaborative modelling is and its diversity of implementation.

3 Diversity of Collaborative Modelling Processes

In this section, we first describe what collaborative modelling is, as a dynamic process at the scale of organisation, allowing communication and interaction among various social groups of scientists and stakeholders. Then we build on the diversity of possible implementation to tackle some dimensions of the invisible infrastructure associated.

3.1 Collaborative Modelling Process as a Communication Process

Participatory modelling started from such diverse origins as medical sciences, farming systems and business management leading to a variety of approaches without real communication between them (Biggs 1989; Cornwall and Jewkes 1995; Voinov and Bousquet 2010; Voinov and Brown Gaddis 2008). This leads to several subcommunities sharing specific tools and application domains. These subcommunities are more related to other groups of the same application domain (e.g., farming, medical sciences, etc.) than to other subcommunities dealing with participatory modelling.

Basically collaborative modelling is a threefold communication process: from participants to model, from model to participants, and among participants about the model. These three potential dimensions of participation can co-exist. They have different values according to the purpose behind the involvement of stakeholders: retrieving information from participants to be included in the model; learning the content and assessing a model for would-be further user; and, implementing collective action patterns on the basis of an interaction pattern made possible by the joint use of a model. This diversity of both possible relations and purposes, together with the multiplicity of participants involved, generates a risk of disappointment due to the occurrence of mismatch between what is implemented as a participatory modelling process, what is reached as an outcome, and what were the very expectations of each given participant including the modellers (Barreteau et al. 2010a).

Probably the most common expectation in studies that have so far implemented such participatory approaches with social simulation models is making each participant's assumptions explicit, included the modellers (Fischer et al. 2005; Moss et al. 2000; Pahl-Wostl and Hare 2004; Etienne 2010). This is a requirement from the simulation modelling community: making explicit stakeholders' beliefs, points of view and tacit knowledge in order to better grasp the dynamics at stake (Barreteau et al. 2001; D'aquino et al. 2003; McKinnon 2005). Moreover, participants need the model's assumptions, as well as the simulation outputs, to be explicit so that they can discuss them and understand how they become part of the model. This is a condition for translating simulation outcomes into new knowledge for participants, and for eventually transferring into operational processes. Undertaking such an activity is aimed at overcoming one major pitfall identified in the development of models: the under-use of decision support models because of their opacity (Loucks et al. 1985; Reitsma et al. 1996). Making assumptions explicit in the modelling process is also a concern at the heart of the participatory approach academic community. One aim of gathering people together and making them collectively discuss their situation in a participatory setting is to make them aware of others' viewpoints and interests. This process involves and stimulates some explanation of tacit positions.

Simulation and modelling of systems at stake may also be of benefit to participation. This kind of process is in need of a set of "support tools", among which models are common candidates. These support tools are supposed to enhance the capacity of a group to compute the consequences of some scenarios, when complex settings are involved or long time horizons. However this benefit is not the only one; models can also act just as mediating or boundary objects, making it easier for communication among participants, or among participants and scientists, to cross the boundaries of their own frames. Externalisation of tacit knowledge in boundary objects (Star and Griesemer 1989) is useful for both: it facilitates communication in providing a joint framework to make one's knowledge explicit; and it enhances individual, as well as social, creativity (Fischer et al. 2005). This externalisation in external dynamic object provides also the opportunity for a safe exploration of potential situations, such as new rules or new tools. Being part of its design, participants can more easily disqualify the outcomes of simulation in a debriefing session (Barreteau et al. 2011). Participants to participatory modelling processes have this time of reflection on what they want to keep from simulations either on an individual or collective setting. Simulation models are seen here as presenting an opportunity to foster participation. Use of simulation models may lead to outcomes such as community building or social learning.

As pointed out by several authors, the structure of interaction co-determines the potential social learning (Daalen and Bots 2006; Pahl-Wostl and Hare 2004; Pahl-Wostl et al. 2008; Bots and van Daalen 2008). The more diverse and unusual the interactions that take place in the participatory process, the more it is likely that participants will learn and build new knowledge during the interactions. Bots and Van Daalen (2008) distinguish three ways in which stakeholders can be involved in a participatory modeling exercise:

- stakeholders are involved individually;
- stakeholders are involved as a group that is considered as a whole by the researcher, independent of stakeholders' diversity;
- stakeholders are involved as a heterogeneous group, meaning that the participants have divergent, and possibly conflicting, interests and problem perceptions, and that the participatory process is organized with sub-groups in order to deal with this heterogeneity.

3.2 Diversity of Implementation of Participatory Processes

Diversity in implementation also takes place in the timing of involvement in the simulation and modelling process (Barreteau et al. in press). The type of exchanges made possible by the collaborative modelling depends on the stage where involvement takes place: from model design, data collection to model use and validation. However these various stages do not have the same capacity to frame the following stages and are not empowering the participants the same way.

Collaborative modelling is shaped by the social network that sustains the interactions. Implementation also varies according to this shape. EU FP6 NeWater project has featured participatory research which took place according to various shapes of networks: star like or more distributed networks, providing a more or less central power to one social group like researchers or some specific stakeholders (Barreteau and Von Korff 2007). This makes another dimension of collaborative modelling. The structure of this group is not really discussed. With this structure of interaction and this timing of involvement, part of the invisible infrastructure associated to the collaborative modelling process is going through: pre-defined format or assumptions come with the authority of a central group or with the irreversibility of previous stages in the process.

4 Examples of Case Studies

Through four case studies of collaborative modelling and water management in France and South Africa, we will give examples of this specific nature of collaborative modelling as boundary institutions. We present here the nature of these case studies while next sub-section and Table 6.1 articulate the lessons learned from them.

4.1 Drôme River Valley: Agent Based Simulation Modelling

In the Drôme river valley, South-East France, a collaborative modelling process had been conducted in the early 2000s to facilitate the emergence of an agreement among farmers to share water at low water season in order to comply with newly agreed basin rule on minimum flows (Barreteau et al. 2003). Main tensions were between the irrigation farming sector and the basin institution representatives considered by farmers as putting too much emphasis on environmental issues. Initially, full distrust was the basis for interaction. The initial requirement for the modelling team concerned the definition of rules, i.e. restriction levels and use of external resource, to reach the minimum flow objective. A first spreadsheet model was developed that engaged both the farming sector and the basin institution representatives in

Table 6.1 Synthetic view of case studies and boundary institutions involved

Case study	Objects	New interactions made possible	Boundary role of modelling process	Rules of interactions in collaborative modelling
Drôme	Spreadsheet model Charter Agent based model	Irrigation institution with basin institution and research	Possibility to explore new rules Grounding a sustainable management strategies	Mediation centralized around modeller Access by small set of representatives Modeller as a fuse
Pays de Caux	Model Game Modelling artefacts	Strengthened relations between mayors and farmers	Elaborate new knowledge on solutions to run off Learn on farmers' views and constraints	Modeller mediation Mediation centralized around modeller Model as a fuse
Sand River	Game 3D model drawings workshops	All sectors representatives meeting for the first time Trust building between local leaders and official representatives	Learn on catchment dynamics Share each others views and constraints in neutral interaction framework	Mediation with model artefacts but actual model building by research team
Alsace	Spreadsheet model Agent based model	Interactions between mayors and experts on their representations	Possibility to explore new connections Possibility to discuss tacit representations of stakeholders	Modeller mediation Modelling team gathers and synthesizes representations and provides it back to stakeholders Suggestions from model are exploratory

discussion. Next an Agent Based Model of irrigation dynamics was collaboratively designed, though interviews of a sample of farmers, and group work on model prototypes with farmers and basin institution representatives facilitated by the modeller. Simulations with the model output of this collaborative modelling process demonstrated that the farmers' lacked water most for field operations when the river was at higher levels and not during the lower stages of flow. This revelation made it possible for both sides to seek a win-win solution. At the same time the modeller, who was also a water scientist, drafted a prototype charter with rules for sharing water among farmers. On the basis of the newly built trust among the farming sector and basin institutions, this draft circulated among them, without going through the modeller again. It evolved into a charter signed by all parties.

The shared rules in interactions in collaborative modelling relied strongly upon the central role of the modeller. The underlying network was a star like network, evolving towards a network with a core part made of representatives, while the role of the modeller gradually diminished in facilitating interactions. One rule was that the modeller and his colleagues consulted both the farming sector and basin organizations for their contributions before synthesizing them in a new model, which was then used as basis for discussion among the group. Another explicit rule in the collaborative modelling process has been an agreement between the modeller and the farmers' representatives that the modeller would act as a fuse[3] in case other farmers would reject the outcome of the process. Finally, this process led to sustainable interactions. Even though the collaborative modelling process is over, the relations are now based on trust among those who participate in the local workshops.

In this case the model and the charter prototype acted as boundary objects: they made enough sense for each world to find suitable indicators of evolution to look at and to be used by them in crafting the final charter. The collaborative modelling process was shared by the various groups at the scale of part of the basin concerned by water shortage issues, and interpreted by them in various ways. The basin institutional representatives based their strategy to build sustainable development of the basin including all participants, with a better understanding of their constraints and expectations. The farming sector representatives took the opportunity of this process to explore new rules for water management in a safe environment—simulation on computer tool under the responsibility of the modeller who accepted to serve as a facilitator. This process initiated a new basis for joint water management in that part of the basin.

4.2 Pays de Caux: Role-Playing Game

In the Pays de Caux region (Upper Normandy, France), a collaborative modelling process has been conducted since 2006 to facilitate negotiations for the future collaborative management of watersheds, which are exposed to erosive runoff.

[3] The analogy is to an electrical circuit fuse. When the circuit is overloaded, the fuse breaks and protects the rest of the circuit.

The process is enhancing discussion among farmers, mayors, and extension services on prevention techniques and agricultural practices (Souchère et al. 2010). Erosive runoff is a widespread phenomenon notwithstanding low rainfall intensity and a mild topography in the cultivated, silty areas of the Pays de Caux and frequently generates modest damage (deposits on seedbeds or ephemeral gullies) and more rarely deadly muddy floods. After the construction of storm basins to solve the problem, it appeared necessary to combine this remedial approach with a preventive process to reduce runoff from agricultural land. Various studies showed that these negative impacts of erosion were partly linked to the lack of coherent flow management at the watershed scale and to changes in land uses and agricultural practices. To reduce damage, runoff has to be controlled not only in the field but also at the scale of the watershed. To be effective preventative the actions that need to be undertaken require co-operation between stakeholders. However, designing collective management of agricultural land is difficult because the economic context means that farmers focus primarily on productive and individual strategies rather than collective strategies across their properties. To design collective management of a watershed is not only a challenge for this reason but also because environmental factors (amount of rainfall, degree of slope, etc.) that influence run-off and erosion vary from place to place in the watershed, generating biases on whose action could be more efficient, where and with which tool. Thus, it was necessary to develop a participatory, collaborative process that incorporates scientific and technical information to address the erosion problem. Scientists from INRA (National Institute for Agricultural Research) proposed to local stakeholders impacted by erosive runoff to use a ComMod approach (Bousquet et al. 2002) to design a role-playing game called "CauxOpération" to promote collective watershed management of erosive runoff.

A series of meetings was held with local stakeholders and we jointly developed a conceptual model using the ARDI method (Etienne et al. 2008) to form the support for a future role-playing game by identifying the main stakeholders, resources, dynamics and interactions linked to the runoff problem. The model was then implemented in a modelling platform (Common-Pool Resource and Multi-Agent System, CORMAS) developed by CIRAD in Montpellier. The role-playing game (RPG) developed from the conceptual model allows eight players (six farmers, a mayor and a watershed advisor) to test a set of solutions in a fictitious watershed and to analyse both the environmental and economic consequences as the game proceeds and in the final debriefing at various scales of investigation (farm and watershed level). To date, four game sessions have been organised in the territory covered by three different watershed management committees. The results of the theses sessions show the learning processes among the participants and the beginnings of joint reflection using the knowledge and representations of each person. During the RPG sessions farmers understood that erosive runoff concerns not only the inhabitants of the downstream towns but also their own upstream farms. For the watershed advisors, the RPG allowed them to test the interest of organizing meetings with all the farmers concerned to design a collective management strategy for runoff. Until participating in the RPG, they usually only had discussions with individual farmers.

They learned that they did not sufficiently encourage the farmers to change their agricultural practices or to adopt best agricultural practices. Watershed advisors tend to favour grass strips and storage ponds because they believe they are most effective actions. This new way of working to identify the possibilities of action inside a watershed was very well received by all the participants.

In this case the model and other material devices used in the process to visualize the various stages of progress in the modelling process acted as boundary objects. The various participants could use the process to test possibilities of actions in a safe environment. They could elaborate and bring back with them new knowledge on solutions to mitigate runoff as well as on others' viewpoints. The modelling team determined the rules for interaction, which were central in this process.

4.3 Alsace Case Study: Agent Based Simulation Modelling

We implemented a collaborative modelling process in northeastern France, the community of communes of Erstein in Alsace. In this territory of ten municipalities at the fringe of the Strasbourg Metropolitan area and its 468,000 inhabitants, we tackled the issue of drinkable water transport, sharing and distribution.

Concerning water and sewerage management, five structures are in place, inside or in intersection with the community of municipalities of Erstein and another community (including Strasbourg Metropolitan area), two different public water companies operate these structures. New legislation is underway focusing on the rationalisation of all these structures. In this context mayors of the Community of communes of Erstein want to keep their autonomy with respect to the large metropolitan area nearby. Control of the water distribution structure as well as control on further possibilities for land development is a crucial dimension of this autonomy.

In order to understand the dynamics of interaction at stake on this territory on the fringes of a large metropolitan area, we started a collaborative modelling process with a group of 15 persons gathering various actors of the Community of Communes that included elected representatives, technicians, and water managers who were not accustomed to meet together nor to share views or plans. This process started with interviews to learn about the territory and the actors and their economic and town planning policies. The second step was to present and discuss with the group a spreadsheet model to make scenarios of water resource sharing in case of pollution of a borehole or in case of a big equipment failure. The third step was based on multi-agent modelling (ABM) bringing in strategic decisions concerning water management as the start of discussion. Both spreadsheet models and ABM are designed by the modelling team on the basis of the knowledge gathered during individual interviews. Models were then presented in collective settings with all the persons who contributed in interviews.

The elected representatives could discuss the structure of these models and outcomes of simulations together with water managers and technicians. They could have this discussion with a view of the whole territory brought by the modelling team, taking into account not only the interactions between their municipality and the nine others within the community of municipalities of Erstein but also with the nearby communities, including the metropolitan area of Strasbourg.

4.4 Sand River Case Study: Role-Playing Game

In the Sand River catchment, northeastern South Africa, a collaborative modelling process was held from July to October 2009. It was an experimental research process with the objective to test a collaborative modelling and simulation framework called Wat-A-Game[4] (Ferrand et al. 2009), which could be used as a support tool for the recently created Catchment Management Agencies (CMA) in implementing collaborative water allocation planning. The process was led through the collaboration of a local NGO (1 project manager, 2 assistants) and a French research team (2 researchers based in France, 1 based in SA, 1 field assistant hosted by the local NGO), with the support of the Catchment Management Agency.

Water allocation planning in South Africa is required to be a participatory process resulting in the definition of minimal requirements and priorities for the different sectors of a catchment. Several tensions existed within and between sectors of the Sand River catchment, a poor and densely populated territory with pine plantations upstream and several big game conservation areas, including Kruger Park, downstream. The main tensions were related to the distrust of poor farmers in small irrigated schemes[5] towards institutions, towards their own representatives who hardly visit them and mainly support the large scale commercial agriculture that they are competition with them for water use; towards powerful conservation groups whom they regard as a threat for their water rights; towards CMA who does not consider domestic needs of farmers living on the schemes. The conservation representative, who is the ecologist of the big game conservation area of the catchment, was in conflict with the agriculture institution over the bad condition of the irrigation infrastructure, which contributes to ecological damage. He considered small farmers, who also need clean water and well-maintained infrastructure as allies. Finally, forestry, which significantly affects hydrological conditions in the catchment, had just changed departments and was in an uncertain institutional situation and isolated from the other stakeholders. Owing to the contentious and fragmented situation, the NGO had high expectations for the collaborative modelling process to build trust among catchment stakeholders and representatives and the capacity for them to work together. Conservation representatives and small farmers shared these expectations; although, the other representatives regarded the process as a threat.

The modelling process consisted of developing a conceptual model of water sources connections, constraints, respective importance, the impact of sector activities, and the dependence of sectors on water and development options. The conceptual

[4] http://wag.labonne.info

[5] As scheme is defined as the design of water distribution devices within an irrigated area.

model provided the basis for a RPG. The field assistant used elements of the RPG as artefacts to interview individuals and small groups to gain support for the building the collaborative model. This served the dual purpose of informing the model and getting the stakeholders acquainted with the tool. These interactions were also useful in training the NGO assistant. She was translating and helping with the manipulation of the artefacts in using abstractions and artefacts to explain complex catchment level dynamics to the communities who trust her as one of them.

The game was developed by the French researchers using the data from the field assistant interviews thanks to RPG artefacts, local experts' knowledge, and a map of small, irrigated schemes made before by the conservation representative. Two role-playing game workshops were organised. The first one included only the agricultural sector. The objective was to train the lay stakeholders in interacting with an abstract tool as well as focusing on agricultural sector issues that were of interest for the NGO. The second workshop concluded the process and gathered stakeholders and representatives from the various sectors. Other supporting artefacts that the NGO had developed before were used during these workshops: a 3D model of the catchment and drawings representing the sectors and the catchment. The RPG used marbles to represent water and stripes to represent water-ways. It was efficient in helping poorly educated participants in attaining a good understanding of water circulation dynamics within the catchment and the meaning of legal constraints of Ecological and Human Needs Reserve. Agricultural leaders think it is a valuable pedagogical tool for helping lay farmers to understand complex dynamics and interactions. An objective of subsequent research is to create platforms that are simple and adaptive enough to enable poorly educated field leaders to use it with lay actors. During the workshop, the interactions around the game and during the following discussion were acknowledged as useful in understanding each stakeholder's issues. In particular, the lay farmer leader who was trained before had to support the official representative in playing the game. For this the official representative who had never visited the field had to understand concrete issues the lay leader was importing in his game explanations. Finally, the workshop was organised and presented as a test for future decision-making process through simulation, with no link to any actual decision-making. The RPG setting and the publicized absence of stake provided a safe harbor for stakeholders that did not trust each other to begin the process of learning to communicate one with the other. The trust previously built among agricultural sector by the NGO as well as the remarkable personal capacities of our field assistant in gaining the commitment of stakeholders contributed to the success of the RPG.

Before the collaborative modelling process started, the underlying network was a star shaped network with the NGO at the centre and in strong interaction with CMA, representatives from conservation and lay people, from agriculture, municipalities, and forestry. During the workshops, we managed to get a complete star network where CMA shifted to the centre and some links were created between lay farmer leaders and their representatives, and with lay farmer leaders and the conservation representative who used to monitor water quality in the catchment. The process has ended too recently to draw any conclusion about the persistence of these links but it definitely was a neutral arena, which helped in establishing contacts and trusts.

5 Discussion

The description of four case studies in previous section provides specific examples of the boundary institutions generated by a participatory modelling process. However a full description along all the dimensions of the concept would need a more reflexive analysis as far as the invisible infrastructure is at stake. We deal with this dimension in the last part of this discussion, due to the crucial issue of the implicit choices hidden behind this infrastructure which should deserve more attention in further work.

5.1 Participatory Modelling as a Boundary Institution

As summed up in Table 6.1 below, participatory modelling is a boundary institution in the meaning that it provides rules for interaction among groups of stakeholders without any prior consensus. These groups may be in conflicting relation as in the Drôme case or simply with a lot of tacit unshared knowledge. It is flexible enough so that various interpretations of the rules as well as of the artefacts used can generate different learning for further actions according to the groups involved. Simple models and their library of indicators and the gaming implementation are particularly at use on interfaces between stakeholders with different background in terms of stake (sector), economic level, education, or location.

These four examples present features of boundary institutions. The rules of interactions around the model, with the well accepted and legitimate roles of modeller (as a neutral facilitator in an exploratory stance) and model (as a first description on which to react). There has never been any need for a prior formal agreement on using the model between various groups. For the involved groups, it could generate action on their own world: empowering some people in the Sand River, establishing a more inclusive policy for integrated basin management in Drôme, exploring further possible connections among water sources or possible rules of water management in a politically safe environment in Drôme or Alsace, and generating knowledge used in further actions in Drôme or Pays de Caux.

Finally in all cases, models were interpreted within each group or by each stakeholder with their own eyes and their own indicators. The flexibility thanks to the various possible viewpoints on these models made that possible.

In three of these cases participatory modelling was successful in generating new interactions between social groups with few contacts among them but conflict before. In the Drôme basin it could even evolve into a new infrastructure, a charter specifying rules to share water. In the Pays de Caux, local stakeholders in relation with local policy institutions started to get acquainted with this kind of process to implement it by themselves. In the Sand River powerless small farmers gained some legitimacy.

5.2 The Invisible Infrastructure

A last important dimension of boundary institutions remains to explore: the infrastructure, with its norms, standards, categories, which is invisible but underlying the existence of the boundary institution. With a reflexive analysis it is difficult to make explicit this dimension of the boundary institution. Some choices are still clearly underlying and are conveyed by the participatory modelling process: in the Drôme River valley, water management is considered as an issue of flow management and productive uses take a predominant position in a bargain with environmental constraints. In the Pays de Caux, actors who interact directly with the flow have an increased legitimacy in dealing with runoff issues and actions that can be made.

What is important is that these invisible elements are not discussed and according to the choice in implementing the participatory modelling process, they can be hidden deeply. This means that de facto some actors, some social groups, who would not fit with this infrastructure, will have more trouble in getting involved without a possibility to clearly express their "malaise".

Thévenot (2001, 2006) has developed a framework to analyse relations of humans with the world around them, based on pragmatic regimes of engagement. This framework distinguishes three categories, or regimes:

- Justification with moral principles;
- Defence of interests;
- Familiarity and proximity with the environment.

For each category, several modalities exist. Thévenot proposes for example six main justification principles (Boltanski and Thévenot 1991). The main assumption is that in their relationship with the environment, people will ground their actions on elements potentially coming from the three categories. The key issue for participation is that the current format for deliberative democracy[6] is not suitable at least for the third category, and the search for compromises between heterogeneous principles is not an easy task. *A common element of the invisible infrastructure included in participatory modelling is this added value given to moral and strategic regimes.* As far as participatory modelling is concerned, it is crucial to have settings which provide some legitimacy or at least some incentives for participants to act and contribute with the whole spectrum of their regimes of engagement, i.e. with their rationales coming from the three categories when it is relevant. Otherwise, we might lose some contributions. For example, in the game Concert'eau, Audrey Richard-Ferroudji designed a specific setting to suggest to participants that they have proximity links with a virtual environment in order to learn how these participants deal with these in a public setting (Richard-Ferroudji and Barreteau 2011).

Finally literacy of participants with models is another concern to be addressed. The companion modelling community has developed several ways to implement conceptual agent based models in computer models, games or hybrid tools in

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[6] See Chap. 11 for a discussion of deliberative democracy.

between (Le Page et al. 2011). According to several experiences of that group, the choice between these various implementations allow the inclusion of different categories of participants. For example a computer ABM has been explained and discussed with farmers from Senegal river valley who had never seen any computers before (Barreteau et al. 2001). There is actually a large set of possible tools to mediate a collective building or use of a model, adaptable to the experience of participants and for the ease of the modelling team. For the participatory modeller, the purpose is to provide a suitable environment for participants either to contribute through bringing new information, or to be able to grasp what is in the model so that they can join a dialogue process supported by it, or provide critiques on the current representation of their system.

This invisible infrastructure does not disqualify participatory modelling: as a boundary institution it provides infrastructure including rules to facilitate interaction in the complex world of water management. It provides good candidates to progress on issues of natural resources management in practice. Relation with an exploratory stance (Auray 2006) is notably crucial. But it should not be considered as a panacea without any further research. A cautious analysis of the invisible infrastructure which is conveyed with implementation of participatory modelling requires further specific investigation in order to prevent from giving an unbalanced role to participants without having this explicit.

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Chapter 7
Challenge of Integrating Natural and Social Sciences to Better Inform Decisions: A Novel Proposal Review Process

Kalle Matso

Abstract Many reports have called for changes to how science funding agencies support research efforts so that more knowledge is linked with decisions. However, few of these reports have delved into the messy details of how to actualize this goal. The purpose of this chapter is to focus in on one example of a funding organization attempting to better bridge the gap between science and action. The mechanisms for making these connections are discussed in detail, as are the views of various people involved in the proposal review process: program managers, peer reviewers and panelists. Several lessons emerge from this qualitative research. Perhaps the most important lesson is that bridging activities require the same level of focus and expertise that is given to the generation of new knowledge about natural systems. This requires a change in how resources are allocated and it also requires the involvement of a class of professionals that have, to a significant degree, been excluded from many environmental research endeavors. This lesson and others have important implications for scientists seeking to solve problems as well as for research program managers and the higher echelon managers of science agencies who make decisions about how resources are allocated.

Keywords Science and technology policy • Decision support • Sustainability science • Research and development • Boundary organizations • Policy-relevant science

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1 Introduction

Previous chapters have already established that our society faces significant challenges. Further, traditional approaches to the conduct of applied science – science that is funded with the express purpose of addressing resource management issues – may not be the most effective use of taxpayer dollars (e.g., (NRC 1995, 2006; Urban Harbors Institute 2004; Jacobs et al. 2005; McNie 2007; RATF 2007; Sarewitz and Pielke 2007)). For our funding organization, known as the NERRS Science Collaborative, (NERRS stands for the National Estuarine Research Reserve System), these reports are especially resonant, because our own evaluative efforts (Riley et al. 2011) have revealed a list of lessons learned that closely mirrors those found in these and other publications. For example, the main principles spelled out in the recent National Research Council (NRC) report, "Informing Decisions in a Changing Climate" (NRC 2009) show considerable overlap with our lessons learned. Hereafter, I will refer to this document as "Informing." The six principles in "Informing" are: (1) begin with users' needs; (2) give priority to process over products; (3) link information producers and users; (4) build connections across disciplines and organizations; (5) seek institutional stability; and (6) design processes for learning. (See, especially, the overlap between these principles and the hypotheses in NRC 2006).

The staff at our organization is also especially qualified to note the difficulty involved in integrating these lessons learned into the way we do our jobs. We have heard loud and clear that we need to provide more opportunities for producers and users of information to work together (Urban Harbors Institute 2004; USCOP 2004; Coastal States Organization 2007). That, in itself, is a challenge. When do you get the users and the producers together? How often? How do you know which people to involve? These are difficult questions for a science funding organization, and especially for one that distributes funds through a competitive grants process. These sorts of organizations often lack the agility and discretion of research divisions that are internal to a science agency. And yet these organizations represent a significant percentage of the science that is conducted to address environmental challenges.

But there's a further complication. The NRC report clearly emphasizes "process" over "products." This is one of those phrases that has more and more significance the longer you look at it. As noted in earlier chapters in this book, the traditional science paradigm is focused on the quality of the scientific end product…not the process. Of equal import are the many publications that have noted the importance of a particular kind of expertise associated with managing this process (Cash et al. 2002; Jacobs et al. 2005; NRC 2006; Karl et al. 2007; RATF 2007). This is not just about meeting facilitation, but about structuring a process involving users that is appropriate to the problem being addressed. This is not a skill that is taught to natural scientists or decision makers…nor even all social scientists. Moreover, it is difficult, even for process experts, to agree on one publication or guidance document that clearly and pragmatically explains how to navigate the many choices that arise in structuring a collaborative process (e.g., Von Korff et al. 2010).

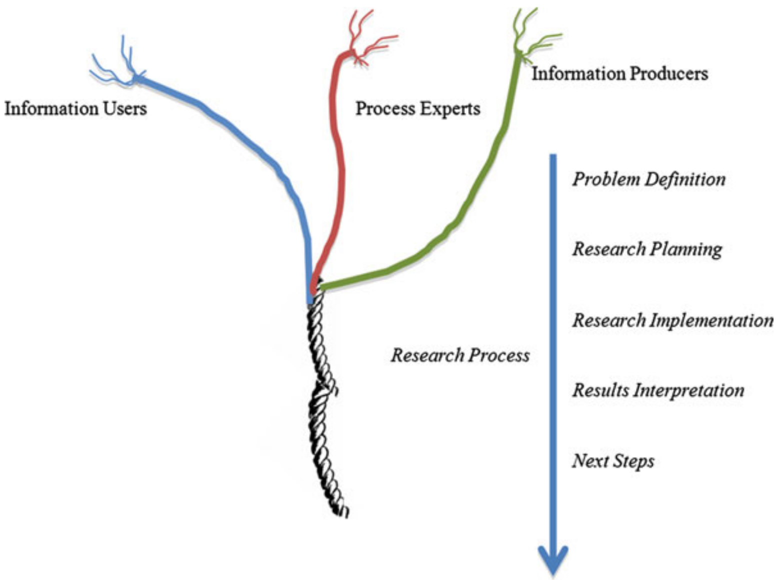

Fig. 7.1 "Braiding the Rope"

I should state at this early juncture that I am not using the term "collaboration" or "collaborative process" in its usual manner. By these terms, I refer to interactions and working partnerships between knowledge producers and knowledge users: for example, between a fisheries scientist and a fisher, or between a hydrologist and a municipal land use planner. I am not using the term "collaboration" to refer to scientists from different disciplines working together.

The challenge to funding organizations is bringing these disparate groups together: the information producers, the users and the process experts. These three veins of system actors have to be weaved into one strand in a way that dovetails with the basic steps of a research endeavor: problem definition, research planning, research implementation, results interpretation and assessment of next steps. I will refer to this challenge as "braiding the rope." (See Fig. 7.1). Braiding the rope is a challenge in any context, but may be especially challenging for funding agencies, which must deal with more rigid timelines and budgetary constraints than, say, a watershed organization or privately funded research institute.

So…what is a competitive grants based funding organization to do?

Two general answers to the question above may spring to mind: two options on opposite sides of a continuum. Option (1) Ask for teams of information producers and decision makers to submit plans to work together…and then use a separate step – after the review stages – to bring process experts into the picture. Option (2) Ask for teams of information producers, decision makers and process experts – all up front – and review the proposals according to the evidence that they can balance the information production side with the process requirements side. While other options surely exist along or even at angles to this continuum, I submit this as a model for orientation purposes.

What follows is the story of our organization's first attempt to address the recommendations of "Informing" (as well as previous reports and publications) and focus on process. Through the telling of this story, I hope to shed light on where on the above continuum applied science funding agencies may want to take aim. But in addition, I hope to provide insight into the challenges faced by our science system (comprised of funders, information producers and users, and process experts) in building sustainable science-based efforts to manage natural resources. Within this chapter, you will find many notable findings. Since these findings come from an inductive case study, they could be turned into hypotheses to be tested in a more focused manner. Some of the most notable findings are:

– There was considerable consensus – across social and natural science disciplines and including policy makers – that more effort is required to connect science to decision makers. Nobody explicitly refuted the idea that our current system of generating and disseminating scientific knowledge was inadequate in light of our challenges.
– Having said that, there was considerable difference in how natural scientists versus social scientists (and process experts) viewed the nature of the problem and how to fix it.
– In addition to seeing the world differently, there seemed to be an awareness gap between the natural scientists and the process experts. Specifically, the process experts were aware of the importance of natural science but natural scientists were often unaware or dismissive of collaborative process experts.
– Natural scientists saw collaborative processes – deeper involvement of intended users in research planning and implementation – as being at tension with well-planned and credible science. Collaborative process experts, on the other hand, did not see credible natural science and credible collaborative processes as mutually exclusive.
– Reflecting the NRC's (2009) notion to focus on "process over products," a subset of the collaborative process experts seemed to question the creation of scientific products…even more useful scientific products…as the *sine qua non* output of research. Rather, they pointed at the creation and/or nurturing of relationships – especially between scientists and decision makers – as a more important output, especially with respect to environmental sustainability.
– There is evidence that funding organizations can change relationships and approaches to science, simply by constructing a review process that forces increased communication between natural and social scientists and between scientists and decision makers.
– There is also evidence that funding opportunities that make increased demands with regard to collaborative processes may alienate some natural scientists.

Is our case study generalizable to other contexts? In our experience, funding applied science since 1997, these lessons learned are generalizable, at least to some extent. Put it this way: there is little evidence to believe that the people interviewed and surveyed for this analysis are not representative of the perspectives at play in the halls of the directorates where funding priorities are set. If that is the case, this chapter may point to part of the reason why funding agencies have been somewhat sluggish in responding to many calls for changes in how research dollars are allocated to better address pressing resource management issues. Let's take, for example, the National Oceanic Atmospheric Administration (NOAA), which is the home of our organization, the NERRS Science Collaborative. Consider this rather damning statement from the preface to an NRC report on climate change and social sciences (NRC 2010). "NOAA recently completed a review of its progress since a highly negative report in 2004 on its social science capability detailed its inadequate expertise and resources. The 2009 review…found that not only had NOAA failed to make significant progress, it had actually lost ground over the 5-year period.")

Why are NOAA and other federal agencies slow to respond to continuing calls for change? Is it possible that part of the problem is the composition of natural scientists and engineers versus social scientists and process experts in the major funding agencies? Since humans are driven by their values and habits (Poliakoff and Webb 2007), and since the major science agencies are dominated by engineers and natural scientists, should we be surprised at our nation's continued failure to maximize our production of decision-relevant science? This is a hypothesis that requires further exploration.

It is hoped that what follows will provide further dimension to these questions and assertions. The chapter is broken up into the following sections:

– Background on our funding organization and the RFP at the center of this case study.
– Qualitative data from our analysis of our most recent RFP, which represents a quantum leap (for us, at least) in terms of explicit measures to create decision-relevant science.
– A comparison of our approach with that of the David and Lucille Packard Foundation (Science and Conservation Division).
– A synopsis of lessons learned woven into the excellent guidance provided in the "Informing" document.

2 Background on the Collaborative and the RFP

The NERRS Science Collaborative is a competitive grants program, funded by NOAA, that began in 2009 and has the mission of supporting the development and application of science to address pressing coastal management issues. Grants are meant to go to 28 estuarine Reserves around the United States, or to partners (e.g., from academia, non-profits, etc.) working in concert with the Reserves. The mandate of the Reserves System is to conduct research, stewardship and education in order to better address estuarine and coastal management issues.

In deciding how to best "braid the rope," the Collaborative began by reviewing our theory of change – (what we expect to happen and the main mechanisms and

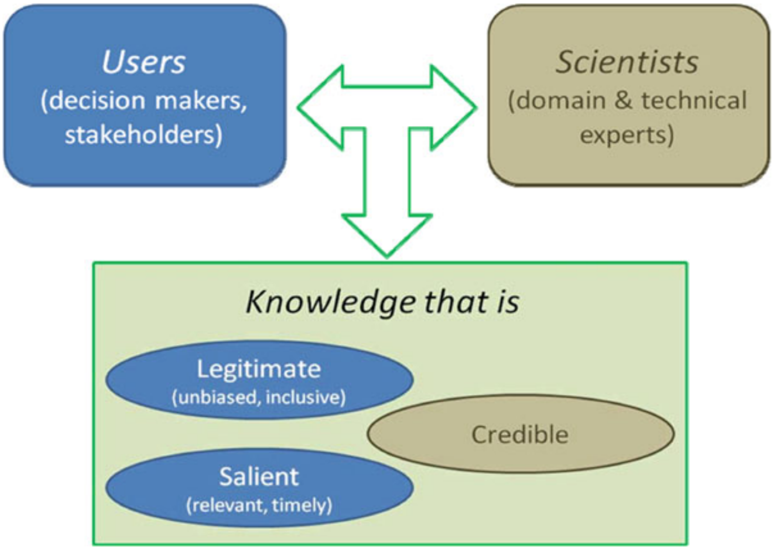

Fig. 7.2 Reproduced with permission from the Packard Foundation

assumptions underlying our expectations). This theory of change is essentially the same as that represented in Fig. 7.2, taken from the David and Lucille Packard Foundation's document "Linking Knowledge with Action" (Packard Foundation 2010). The assumption in this model is that joint production of knowledge is the best way to create knowledge that is credible, salient (i.e., relevant) and legitimate (i.e., trusted and fair). For more information on these terms and concepts (see Cash et al. 2002, 2003; NRC 2009). After considerable debate, we determined that the best way to achieve joint production of knowledge would be by making sure that information producers and users as well as process experts were together from the very beginning: that is, from the proposal stage. As will be discussed later in this article, the Packard Foundation is testing a slightly different approach.

To accomplish this, the Request for Proposals (RFP), released in January, 2010, emphasized two kinds of methods: applied science, which could include natural sciences and/or social sciences, and methods related to the collaborative processes. These two aspects of the proposal were given equal weighting in the review process. In addition, all proposals needed to indicate an "integration lead" whose job it would be to "balance the perspectives of the researchers and intended users throughout the project" (NERRS Science Collaborative 2010). (Let me take a moment to acknowledge that some of these terms – applied science, social science, collaborative process experts – are confusing. They mean different things to different people. Also, they don't have clean divisions. For example, many process experts are also social scientists. The "Informing" report would replace the phrase "applied science" with "science *for* decision support," and replace the focus on "process" with "science *of* decision support." For this paper, however, I will continue to use "applied science"

Table 7.1 Data collection and analysis methods

– Read through all 116 peer reviews (29 proposals times four reviews each), looking for patterns in how the reviewers reacted to the proposals. Analytical methods were based on a qualitative analysis approach called "grounded theory." In grounded theory and similar methods, analysts concern themselves with a specific phenomenon – e.g., What constitutes a truly collaborative process? – but do not set up a limited number of variables or explanations (i.e., hypotheses) before gathering data. Instead, theories are developed from the data, which are revisited in an iterative process of honing on potential explanations for observed phenomena (Strauss and Corbin 1990; Charmaz 2006)
– Conducted in-depth interviews with six applied science peer reviewers and six collaborative process peer reviewers; (stratified random sampling was used in the former case and random sampling in the latter). Coded according to "grounded theory" principles (see above)
– Analyzed evaluative surveys from the ten panelists. Coded according to "grounded theory" principles (see above)
– Asked all 87 peer reviewers which funding programs effectively combine research on natural and social systems; then, conducted interviews with the two programs that were mentioned most

to refer to research about either the natural or human component of the ecosystem; the term "collaborative process" refers specifically to the activities related to connecting knowledge to intended users).

The review approach also reflected our emphasis on a balanced process. We made it clear to all applicants that each proposal would be reviewed by two applied science peer reviewers – (e.g., restoration ecologists, engineers, etc.) and two collaborative process peer reviewers. After the peer review process, applicants had an opportunity to rebut the peer review comments. Finally, a multi- and interdisciplinary panel of ten people was brought in to reconcile all the information and make recommendations for the proposals that best reflected the goals of the RFP.

That was the plan. So, what happened? The short answer is that we received 35 Letters of Intent, 29 full proposals and we funded seven 3-year projects with a cumulative price tag of $4.5 million (average funding request of $642,000). These projects began in September of 2010, and, ostensibly, all provided a detailed plan to collaborate with intended users; considered human as well as non-human barriers to utility; and involved experts in the writing of the proposal and the implementation of the project objectives. All projects had an identified "integration lead" who will strive to balance the perspectives of the various scientists and stakeholders. Many of them included neutral facilitation resources.

However, can we yet say whether these projects represent a truly different way of conducting science? Or is it possible that the ambitious goals in the proposal will be diluted in the implementation phase? Of course, it is too early to say. On the other hand, we knew that our effort was somewhat unusual and we wanted to adaptively manage our program, so we collected information to better understand the most salient challenges to "braiding the rope" so that we might be able improve in the future. See Table 7.1 for details on our analytical methods.

With regard to "braiding the rope," the short answer is that virtually everyone involved in the process – natural scientists, social scientists, collaborative process experts, decision makers who served on the panel – everyone agreed, in principle, with the goal of greater collaboration between information producers and information users. People agreed that we, as a system of actors, need to think harder about how to get science used.

Taking that general consensus, however, and moving toward agreement on how science agencies should achieve that goal is a completely different story. There is considerable diversity, confusion, perhaps even conflict around determining the best methods for braiding the rope. As noted earlier, if the conflict and confusion about conducting applied science in this group is representative of what's happening within government funding agencies, one could conclude that this is a serious problem for us as a society in terms of addressing climate change and other pressing challenges.

The basic area of confusion/conflict is that people are in favor of more collaboration in science, but there is a lack of agreement about *why* collaboration adds value, *what* collaboration means in this context and, finally, *how* a competitive grants program should foster collaboration. While this is less the case with those who spend more of their time in the collaborative process world, we saw some interesting differences in this group as well, especially with regard to the question of why collaborative science is undertaken in the first place. First, I will review what we heard from those who work close to or in the world of collaborative processes. Then, I will go over the salient perspectives of the information producers, most of whom happened to be natural scientists or decision makers with natural science backgrounds.

3 Collaborative Process Perspective, Part 1: The Program Manager

Since the heart of this paper concerns ways for funding agencies to better braid the rope, let us start with input we received from two programs that, according to the community involved in this process, do this effectively: the National Science Foundation (NSF) and NOAA. As part of our review process, we asked all 87 of our peer reviewers (58 on the applied science side; 29 on the collaborative process side) if they were aware of programs that effectively integrated natural and social science, especially in the context of a competitive grants program. Of the 58 biophysical reviewers, ten responded that ours (the NERRS Science Collaborative) was the only program they were aware of and eight suggested other programs. Of the 29 collaborative process reviewers, 12 suggested other programs. NSF received 21 nods from reviewers, most of these (12) were specifically regarding the Coupled Natural and Human Dynamics program (CNH). NOAA received six nods, most of these (4) regarding the Climate Program (see Table 7.2).

We followed up with interviews with program managers from the NOAA Climate Program (Adam Parris) as well as program managers from NSF-CNH

Table 7.2 Programs effective at integrating natural and social sciences

Programs	Times mentioned by reviewers
NSF CNH	12
NSF ULTRA-Ex	2
NSF Geography and Env. sciences	1
NSF Ecology of infectious diseases	1
NSF EPScOR	2
NSF Decision making under uncertainty	1
NSF (no department mentioned)	2
US Long-term ecological research network	1
NOAA Climate and societal interactions	3
NOAA RISA	1
NOAA Sea grant	2
NASA ROSES	1
Social sciences/humanities research council (Canada)	1

(Sarah Ruth and Thomas Baerwald). The interviews concentrated on four questions: (1) Why integrate natural and social sciences? (2) What are the main challenges to integration? (3) What evidence do you see that the integration is actually occurring? (4) What do you think of the idea of having two applied science reviewers and two collaborative process reviewers?

Regarding the rationale for integrating natural and social sciences, both NOAA and NSF agency representatives noted that environmental challenges are rarely related to only one discipline; that is, the problems cross jurisdictions and scales and therefore require integrated solutions and research efforts. In terms of the challenges to integration, a common comment was that current academic and government structures and incentives foster a silo-based approach and organization. This is difficult to address, although NSF program managers noted that the CNH program has actually helped break down silos at their agency.

With regard to evidence of success, both programs noted strong reputations and high proposal submission rates as indicators that their approaches had merit. Parris, speaking for the NOAA program, noted that impacts of the projects were currently being researched and that early indications were that projects were having a significant influence on target audiences. The CNH representatives acknowledge the importance of broader impact as a key criterion, but also pointed to NSF's emphasis on strong scholarly work and the publication record of funded researchers.

Finally, in terms of comments on our review process (two applied science and two collaborative process reviewers), both programs noted that it was essential to have different disciplines involved in the review process. Both also noted that, when picking reviewers, it was a good idea to seek out people who themselves had a strong track record in integrated research. In addition, the NOAA manager encouraged the inclusion of decision makers in the review process as a way to increase the relevance of the research. NSF program managers also emphasized the importance of panels over "mail-in" reviews; they noted that significant learning occurred when folks were able to exchange ideas and perspectives.

In speaking with the NSF program managers, I noted the irony that NSF was regarded as being far more effective in integrating social and natural science than NOAA, one of the "mission" agencies. Speaking for NSF, Baerwald noted his frequent comment that, even though NSF is not considered a "mission" agency, it still has a mission. On the other hand, when I mentioned the results of this survey to a scientist who was familiar with NSF-CNH, this scientist disputed the idea that CNH and the Collaborative were trying to achieve similar goals. In his view, CNH was still mostly interested in creating scholarly benefit, whereas our RFP was heavily imbued with an emphasis on intended user benefit.

Coming back to the confusion around why collaboration adds value, what collaboration entails and how it should be achieved, these interviews give us the beginnings of answers to the "why" and "how" questions. Collaboration is done to improve the value of the science and to better address natural resource management challenges. In terms of "how," an interdisciplinary approach is required. You will see these answers expanded upon as I analyze feedback from the collaborative process reviewers, both from the interviews we conducted and from the qualitative comments in the peer reviews themselves.

4 Collaborative Process Perspective, Part 2: The "Experts"

So, first of all, who are these experts and how did we find them? We started with an excellent review paper (McNie 2007), which led us to specific journals (e.g., "Ecology and Society," "Society and Natural Resources") where we searched for authors who fit the profile of the "scholar-practitioner," or the "pracademic." We wanted to find people with real-world experience participating in and observing collaborative research endeavors. Of the 29 reviewers, 28 of them were based at 4-year colleges or universities, mostly in departments such as geography, public affairs, planning and natural resources. We noted that these reviewers described their expertise in varying ways, with the phrases and terms "participatory," "public engagement," "collaborative," "community-based," and "deliberative decision-making" showing up most often on their web sites.

The best data on *why conduct collaborative science* comes from the six in-depth interviews we conducted with collaborative process reviewers. You will see that the perspectives are similar to those of the NOAA and NSF program managers. For example, at the end of one interview with a collaborative process peer reviewer, the reviewer was asked, "Anything to add?" to which he responded.

> No, I think it's [trying to be more collaborative] a really important thing. It's been long assumed that if people develop smart things, they'll be used, but people like me who do practitioner based social science research know that that's a fallacious argument. There's a lot of research that shows that tons of money just goes into reports that are shelved and so I think it's very important to be frontloading with collaboration.

This remark epitomized the views of the other five collaborative process reviewers, and, in fact, most of the applied science reviewers as well. (As noted earlier, everyone agrees there's a problem; the question is what to do about it). However, one of the other reviewers also emphasized that collaborative processes can easily be done in a less than rigorous way, with negative consequences.

> The two proposals I read… one of them didn't address integration and collaboration at all. They assume that if you bring people together, you've done collaboration…that's wrong and it can do more harm.

So, collaborative processes are used in order to increase the value of science efforts. Yet the question of how we assign value to scientific activities comes up as a more difficult question in these interviews. In particular, interviewee responses forced us to ask: Should the goal of collaborative research be influencing one specific decision/endpoint, or should the goal be growth in relationships and learning around a particular issue? This is a key point that would impact how a funding program was implemented. Specifically, two of the six reviewers interviewed focused on the trust and relationships that occur when producers and users of information engage in a learning process together. In this scenario, the implied benefit is not so much coming to agreement on one particular decision, but rather a broad increase in understanding by all the participants. For example, information producers learn more about the concerns of certain stakeholders or perhaps become more aware of local knowledge around an issue; stakeholders, on the other hand, become more appreciative and aware of certain scientific endeavors that have already taken place or are in the planning stages. In theory, this then leads to a more educated and collaborative society, which has the potential to impact many decisions…including the decision that is the focus of the project, but not limited to it. One of the peer reviewers put it this way:

> The literature tells us that getting decision makers to use high quality science is partly about producing good science but it's also about building relationships. When I was reading the proposals, at least, I was looking at, 'OK, what is this project going to produce' but I was also asking, 'What are these folks going to have to say to each other two years after this project is over?' Is it going to occur to these people, when they need some random piece of information…oh, I can call this person and get some information.

Another collaborative process interviewer actually went a step further, noting that focusing on one specific decision would detract from the trust building and learning that might otherwise occur.

> The danger that maybe showed up in a couple of my proposals is that if a proposal is thinking about a very specific management decision, they're apt to emphasize the science and maybe downplay the collaborative side in the interest of getting to that decision.

This reviewer went on to break collaborative research into three types.

> There's the science; there's the collaborative process around the science; and then there's collaboratively developed science, actually to decision making, and I would say they are three different things. And perhaps your RFP emphasized really the first two of those. The fact is that very often neither the scientists nor the collaborative process people really know how to make those links to the real decision makers.

Confusion around this issue definitely emerged during the panel negotiations as well. Several of the ten panelists noted in their evaluations that, in their interpretation, connecting science to decisions didn't require as much emphasis on process and extensive stakeholder interactions.

> You can have very effective science to management linkage by incorporating a key decision-maker into your PI team and research effort. You don't always need broad collaborative approaches.

Obviously, this panelist has a different conception of why collaborative processes are being invoked in the first place. I want to be clear that I am not deeming this perspective "wrong." But it is different from the views of the collaborative process reviewers quoted above, and would have significant implications on the strategies employed by the funding agencies as well as the project teams.

In contrast, one of the other panelists expressed concern at the other end of the conceptual spectrum. In essence, this panelist worried that if we, as a society, continue to seek proposals that are narrowly construed around specific decision makers and natural science issues, we will not be able to make the necessary changes to better address environmental issues. Our process, in this panelist's estimation, put proposals that emphasized stakeholder assessments and flexibility at a disadvantage.

> Most proposals did include a reasonable collaborative and integrative approach. However, per the discussion, a couple of proposals that were models of a true stakeholder participatory approach from the very beginning suffered because they could not adequately define the [natural] science. Given the conditions of the RFP, proposals such as these will never stand a chance of funding.

This panelist's concern is valid. However, the solution may not necessarily be in changing the RFP process so much as making it much clearer that proposals focused on better understanding social science barriers (e.g., stakeholder perceptions) are completely valid research proposals. A potential retort to this line of thinking is that this doesn't address the notion expressed by the NOAA and NSF program managers that natural and social science should be happening more simultaneously, since the issues themselves occur in that manner. This is also a valid point and gets at a much trickier question that we are just beginning to grapple with: How to guide applicants in setting up a process that both demonstrates flexibility with regard to stakeholder ideas, but also provides enough detail on the natural side so that reviewers can evaluate the validity of their methods? While this is no doubt challenging, published reports of case studies indicate that it is possible (e.g., Cockerill et al. 2006) and that "clarity and flexibility do not exclude each other" (Barreteau et al. 2010). As one of the collaborative process reviews put it:

> A more genuinely collaborative approach would involve alleged pollution creators…and direct pollution sufferers…in both carrying out the monitoring and deliberating over the solutions. Such an approach could still incorporate the technical innovations that currently form the core of the applicants' proposal. But it would avoid the well-known problems in terms of both internal validity and stakeholder acceptance.

This discussion touches on an important related issue, concerning the perceived limitations of short (i.e., 3 years or less) collaborative science projects. Is 3 years really enough to achieve any significant goals from a collaborative standpoint? This question was actually put to peer reviewers in the interviews. While some noted that

1 year might not be long enough, most thought that the allowed time periods for the proposals (1, 2 or 3 years) was appropriate. However, this was often followed with the caveat that other funding will be necessary to continue to nurture the relationships that were supported by our funding.

Again, are we only interested in one particular decision or product, or are we also interested in building collaborative capacity for the future? (In this case, collaborative capacity can be thought of as the willingness and capability – implying some process expertise – for both producers and users of knowledge to work productively together). This is not black and white, of course, but rather exists on a continuum, and as the needle leans toward trying to increase collaborative capacity, both the funding agencies and applicants have to realize that the process never really ends, at least according to some of the interviewees.

> That's a big challenge of this work; it's never really done like a discreet research project that ends with a peer reviewed publication. Yes, it's a great approach; it can only help, but it doesn't end in three years.
>
> (Note that the above thought comes from an extension person who served as an applied science reviewer, not a collaborative process reviewer.)

One of the collaborative reviewers noted that our RFP model requires that much of the collaboration happen outside – before and after – the time limits of our process and funding.

> In having conversations with others about collaborative research, I have come to the fairly strong opinion that most of the best collaborative partnerships and work take place in the context of a long-term relationship. Not all projects have to follow that model, and not everyone's going to agree with me, but my own experience has been that this has been a major factor. So what happens is that if someone's trying to write a really strong collaborative proposal, they have to do a lot of preliminary legwork and relationship building before even thinking about writing a proposal. That then places a whole burden on people to do unfunded work, unless they're building on a project with folks they already know. So that's the sort of chicken and egg problem that you guys are stuck in the middle of.

This same reviewer went on to note that, because of this tension, the NERRS system is well-placed to respond to our RFP because of their ongoing mission to maintain relationships with decision makers from their regions. Coincidentally, this approach mimics that of the Research Coordinator at the Elkhorn Slough Reserve, near Monterey, CA. This Reserve has actually obtained funding from more than one funding agency focused on significant collaboration. In response, the Research Coordinator at the Reserve has come to the realization that the best course of action is to have continuous, on-going collaborative conversations on various issues so that the Reserve and various working groups will be well primed to apply to collaborative RFPs when they arrive (K. Wasson, 2010, personal communication). Ultimately, this becomes a more efficient model than trying to start up a collaboration from scratch when a new RFP comes around.

In summation, on the question of "why" conduct collaborative science, there is little dissension with the idea that it can lead to greater linkages to decision making, which is the ostensible reason that the science was funded in the first place. Further exploration with these reviewers and others would be necessary to more

Table 7.3 Collaborative science guidance from the 2010 RFP

By "collaborative approach" we mean one that integrates intended users of the science in the development of the proposal and implementation of the project. When this is done in an explicit way, with the appropriate resources, it can enhance the likelihood that intended users perceive project results as credible, relevant, and legitimate – three qualities that are often required to successfully link science to decision making. More resources on this topic are available in the Collaborative Approach to Science Primer, beginning on page 15
From the Collaborative Approach to Science Primer
Based on our experience and the literature, we believe that projects with the strongest chance of connecting science to decision making have the following characteristics:
• Investigators involve intended users of project results in the problem at every critical stage of the project;
• The project team has allocated appropriate resources to manage the interactions between investigators and intended users;
• The project team, including subcontractors, has the appropriate expertise to manage interactions and balance perspectives between researchers and intended users
The following models have been applied effectively to address coastal management problems. While there are subtle differences to these approaches, all provide explicit mechanisms to integrate a variety of perspectives, including those of project investigators and intended users, at critical stages of the project. You are not obligated to use these approaches in your proposal. Rather, they are provided as examples to illustrate the level of rigor that reviewers will expect you to apply to collaborative processes
Consensus building web.mit.edu/dusp/epp/music/pdf/JFF_KeySteps.pdf
Collaborative learning model oregonstate.edu/instruct/comm440-540/CL2pager.htm
Structured decision making www.structureddecisionmaking.org/steps.htm

satisfactorily understand what the long-term and intermediary outcomes of collaboration are. Some of these reviewers focused on relationships and learning as opposed to knowledge linking to specific decisions.

In terms of the question related to *what characteristics define collaborative science*, I address this by looking at what collaborative process peer reviewers found most wanting in the proposals they reviewed, and their articulation of what was missing. (Our in-depth interviews with the six collaborative process reviewers focused on why and how to collaborate: not on what the basic characteristics of collaboration are).

For context, it's important to know how we tried to answer this question in the RFP. In this guidance, we attempted to walk the line between being explicit about collaborative principles but not micromanaging and prescribing a particular process, out of respect for the fact that the 28 Reserves are very different and might have different ways of working. Table 7.3 has a summation of the key advice we noted in the RFP.

In the way of foreshadowing, I can say that none of the results below contradict the definition of collaboration given in Gray (1989), most often used by people in the field as a starting point for discussion on what collaboration entails. This definition notes that collaboration creates "a richer, more comprehensive appreciation of the problem among stakeholders than any one of them could construct alone."

Table 7.4 Most common collaborative process criticisms

Category	# of Collab process reviews	# of Applied science reviews
Reviewer wanted more details on collaborative processes	34	11
Reviewer wanted more expertise related to collaborative processes/social science	25	4
Reviewer wanted more information on non-technical barriers	23	9
Reviewer felt that applicants confused collaboration with unilateral info dissemination	19	2
Reviewer wanted more evidence that intended users were involved in problem definition	18	5
Reviewer took issue with the content (not amount) of the collaborative process details	15	2
Concern for how products of research will be used	15	15
Reviewer said proposal showed applicants were not familiar with collaborative methods	14	2
Reviewer wanted a broader group of intended users to be involved in the project	14	2
Reviewers felt more money should have been allocated to the collaborative process	10	5
Totals	187	57

The results of this analysis are shown in Table 7.4. I will go through the top five rows in more detail, offering examples of how reviewers articulated what they thought was missing. These top five rows account for 119 of 187 negative comments made by collaborative reviewers (or 60%).

4.1 *Rigor…and That Means Details!*

Peer reviewers clearly articulated that a *collaborative process requires detailed forethought and planning*. In general, reviewers used amount of details as a measure of the seriousness with which applicants addressed collaboration and as a measure of their ability to carry collaborative processes out. The following quotes give a sense of how collaborative reviewers reacted to a lack of details:

> The proposal talks of treating stakeholders as equal partners, but that isn't really what concerns me. It's okay if there is inequality, because people have different things to contribute. But what is important is that they have some idea of what the different people are going to do. The whole stakeholder aspect of this proposal is vague and unspecified. In a really strong proposal there would be a clear outline of what would happen at each meeting and how the progress would be measured with clear objectives and criteria for evaluating success.

> The sentence I think is strongest in this section [relates to exchanging information between stakeholders and investigators]. I would recommend that the proposal unpack this statement a little more and think more about how this will actually be done, and done in a systematic and structured way, not simply haphazardly.

> While some project team members may have understanding and expertise in collaborative approaches to outreach, communications, and research partnerships, the lack of detail and integration in the present proposal suggests that this dimension is an add-on to the monitoring activities, not a full collaboration.

4.2 *"Get the Right People on the Bus"*

This quotation is taken from the Jim Collins book "Good to Great" (Collins 2001) and refers to the importance of having the right people on the team in order to get the job done. This is articulated clearly by one of the collaborative process peer reviewers. The following quote is taken from an interview.

> One thing the [natural science] experts don't think about is that the collaborative process is a skill in and of itself, same way being hydrologist is a skill. Same way you have to scale [the natural science] side, you have to scale the collaborative components. But you need someone who knows what that means in the process.

With regard to expertise, the collaborative process peer review criticisms can be put into two general categories: (1) the proposal did not recognize the importance of specific expertise; (2) the proposal made a gesture toward satisfying collaborative process requirements, but the overall effect was less than what would be required to maximize chances of success. Below are some peer review reactions that fit in the former category.

> As noted above, the proposal is strong in engaging a number of government entities and scientists/researchers, but falls a bit short in the lack of social scientists involved and/or collaborative/public participation specialists involved in the project.

> The proposal would be strengthened if senior project personnel included a social scientist well versed in collaborative approaches and/or public engagement in natural resource decision-making.

> Were the project to be substantially adjusted to take into consideration my above concerns [related to better collaborative processes], however, the lack of someone with substantial experience managing deliberative decision-making processes would become conspicuous.

In contrast, here are reactions to proposals that made some effort, but not enough to convince the peer reviewers. As you'll see, reasons include a lack of evidence that the appointed person really has the expertise; conflating facilitation expertise with the experience necessary to design a collaborative research project; getting a qualified person but not giving them the resources to do the job.

> The team is very strong in biophysical sciences, and very weak in social sciences. I have confidence that they can undertake the biophysical analysis piece of the project, and no confidence that they can conduct a social survey, benefit cost analysis or risk assessment, given the information provided in the proposal. [Name Removed], with a planning background, is perhaps the one who might be able to do the social science work, yet he is not supported in the budget so it is not clear what his participation in this project will be.

> Scientific and technical skills are excellent. Skills for collaboration are lacking. Facilitation does not necessarily equal true collaboration.

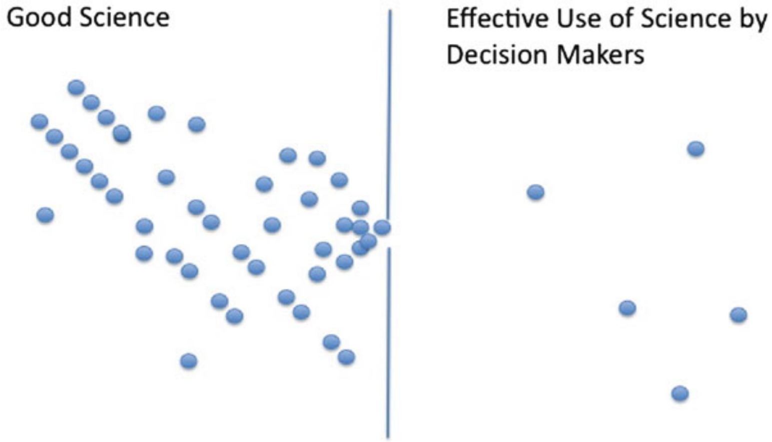

Fig. 7.3 This figure depicts a situation wherein many research projects generate credible science (left side of the figure), but there are far less instances of credible science linking to decisions (right side of the figure.)

> I do not see skills represented on the team to carry out collaborative processes, only past participation in other processes (which is not evidence of practical skills at running such processes or theoretical knowledge of the barriers to collaboration).

In following up with folks from the Reserves after the RFP process was concluded, we were surprised by the amount of confusion circulating around the issue of expertise, and especially around the issue of the role of social science in collaborative processes. The confusion came from multiple sectors – the Reserves all have different "sector" coordinators, including: research, education, stewardship and the coastal training program, which is responsible for linking activities at the Reserve to decision makers. The coastal training program coordinators were intimidated by the idea that they were now expected to be social scientists. Although they are constantly engaged in activities around better understanding decision makers, many of them think of "social science" as something different, more laden with ivory tower connotations. Research coordinators, too, struggled with the idea. This was best articulated by one research coordinator, who referred to a schematic I had shown during a presentation (Fig. 7.3). In this figure, crowded dots on the left side of the diagram represent credible science and much fewer dots on the right side of the diagram represent effective use of science by decision makers. The research coordinator noted that she didn't disagree with the implications of the schematic. However, she said that we have to be clear whether collaborative processes are about conducting social science that could, potentially, become another stranded dot on the left, or whether it is instead an effort to break down the bottleneck allowing information to flow back and forth. (K. Wasson, 2010, personal communication).

Her clarification is right on point; the latter conceptualization is, in fact, how we conceived the role of the collaborative process expert, whether you want to term their activities “social science” or not. It is also possible, however, that the main goal of the project could be to better understand a social science issue, such as stakeholder conceptions of risk regarding sea level rise, etc. In this case, the project would still require a collaborative process piece in order to make sure that the social science knowledge doesn’t languish on the left side of the diagram.

4.3 *Lack of Understanding of Natural Systems Isn’t the Only Barrier*

A collaborative process does not assume that the only problem is a lack of information about the resource. It assumes, in contrast, than even if everyone has the desired natural system information, there will be some barriers to using the information to make decisions; usually these barriers have to do with the logistical limitations on the part of the intended users, differences in values and/or socio-economic issues. In the case of these 29 proposals, especially when those proposals were lead by a natural scientist, the “problem” to be solved was often depicted as a lack of information about the natural system. Then, it was either implied or noted explicitly that, once the appropriate information was provided to the decision makers, these users of information would change their actions or behaviors accordingly.

This is not surprising. As the old idiom goes, the challenges that are most interesting to a hammer tend to be nails. Why would a natural scientist go to the trouble of writing a proposal and then ask for resources to attack a problem with tools that he is only partially able to provide? It is understandable that a natural scientist would see a coastal management problem through her lens, which would tend to shape problems into deficits in understanding of natural systems. By the same token, a social scientist might see all problems as a deficit of understanding of human and organizational motivations and behaviors.

The following peer reviewer quotations articulate the need to look more deeply into human barriers, not just barriers related to understanding the natural system.

> The basic assumption running throughout the proposal is that once the science is produced, then the “truth” will be obvious and embraced by all [the stakeholders]. But the collaborative literature, as well as political science, economics, sociology, psychology and public administration, among others, suggest that good information is only the start of the decision-making process and that all kinds of barriers get in the way of embracing, much less applying the science.

> In my experience, knowledge deficit is rarely the reason why actions are not happening. More likely, people know what needs to be done, it’s just too controversial or too expensive to do. More information can certainly help, but the people involved in the decision-making need to confirm that this is indeed the major obstacle.

4.4 Collaboration Does Not Mean One-Way Information Dissemination

The peer reviewers articulated that a collaborative process plans for respectful interchanges between various people involved with a natural resource issue. Learning is happening in both directions and, therefore, a collaborative process should seek to specifically facilitate this kind of learning and perhaps, as the reviewer below suggests, set learning and trust building as explicit objectives that are evaluated within the project.

> The project objectives could be stronger if they included increased collaborations as outcomes in and of themselves. As articulated, the objectives are to collect the data and then disseminate the data to relevant decision makers and 'stakeholders.' Certainly this is the model most common in applied science settings -- and the model we generally find in terms of academic and agency collaborations.

As shown in the quotations that follow, specific planning for multidirectional learning was absent in many proposals. Instead reviewers saw ramped up dissemination of information and educating of the public.

> There seems to be a belief that making materials and reports available to anyone who might be interested is collaborative and sufficient for interest groups to make the effort to know, understand and be willing to behave in ways consistent with the research findings. This is a mistaken and often costly belief.

> All that's really discussed is public education/outreach. I don't see collaboration, which is two-way. This reads like a one-way process.

> There is also little indication how the results of the study would help overcome problems with the implementation of the current approaches other than to provide more information that might improve our understanding of how the ecological system functions. While there is potential for the project to do this, it still reads like a more traditional scientific proposal with an outreach component tacked on than one designed collaboratively to help improve coastal management decision making.

4.5 Collaboration Means That the Problem Itself Is Defined in a Collaborative Way

Collaborative processes have to start with the problem formulation and carry through all the other stages. If the problem is not defined collaboratively, it is possible to do everything else right and end up with knowledge that is not used, for the simple fact that it answers a question to which people don't need the answer (Sarewitz and Pielke 2007; Mitroff and Silvers 2010). The quotations below show how reviewers articulated their concerns that the science being proposed might not be addressing the real problem of interest to intended users.

> It is unclear to which extent applicants have confirmed their understanding of the nature of the problem and their proposed approach with intended users.

> It is less clear that the proposed research addresses the core obstacles to moving restoration forward. Though this work may be a priority of the NERR…it is less clear that this would address other constituencies' concerns.

> Frankly, I'm concerned that this project has moved ahead with the assumption that more ecological information is needed, but they have not really field-checked this assumption at all.

Finally, to understand *how* a program like the Collaborative can foster increased collaboration, we must return to the in-depth interviews of the peer reviewers. All six of the interviewees agreed with our choice to involve both collaborative process reviewers and reviewers who specialized in the applied science problem being tackled by the proposal. At the same time, two of the six reviewers registered concern for how we would reconcile such discrepant viewpoints as we would surely get. And three of the six reviewers suggested that we try to provide an opportunity for the two sets of reviewers to talk to and learn from each other, echoing the value put on panels by the NSF program managers. One of the peer reviewers put it this way:

> If you're thinking about building capacity, then the reviewers that participated are a form of capacity for the future, and if you just do it as a sort of blind one sided exercise, than it's not going to be as rich an experience than if you had some process for debriefing.

Other suggestions included being more clear in the RFP what we mean by collaboration and perhaps listing some resources where applicants could find out more information. (We attempted to do both these things, but clearly we need to do it better).

Before we move on to the perspectives of the applied scientists in the process, let us sum up what the program managers and collaborative process experts have said about collaborative process.

Why conduct collaborative science? So that more science is used and natural resource issues are better addressed by applied science endeavors. This (science being used) may happen by better linking science projects to actual decisions and decision makers, and/or it may happen because science projects serve as hubs around which producers and users of information can learn and increase their collaborative capacity, with regard to one or other decisions.

What constitutes collaborative science? Collaborative science involves detailed plans, created by experienced practitioners with specific training, to create an environment in which producers and users learn from each other – at every step of the research process…including the problem definition stage – so that knowledge generated by the science address information gaps as well as values-based, socio-economic and other barriers that can prevent the science from being used.

How should funding organizations foster collaboration? Involving both applied scientists and collaborative process experts is strongly recommended, and efforts should be taken to allow people with different perspectives to learn from each other. (A more detailed discussion of "how" comes later in the chapter).

Now, let us turn our attention to the applied science side of the review process to compare their perspectives with those of the collaborative process reviewers.

5 The Natural Science Perspective

One might think that it's unnecessary for natural scientists to be on the same page as the collaborative process experts. After all, why not let the natural scientists do what they do well and leave the collaboration component to those who have that specific training and interest? However, there are several points we should consider. Natural scientists often play an important role in the natural resource management process and are therefore important stakeholders. In addition, natural scientists are often the predominant applicants to competitions that come from the big science agencies (e.g., NOAA, NSF) despite repeated calls for more social science (NOAA Science Advisory Board 2001, 2009; NRC 2007). And finally, most of the people who hold key decision making positions at science agencies have a natural science background. For example, Jane Lubchenco at NOAA is a marine ecologist; Marcia McNutt at the US Geological Survey is an oceanographer; and Subra Suresh at NSF is an engineer. It makes sense – and most social scientists would agree – to better understand the views of key decision makers and stakeholders. I offer this information as a sample of the applied natural scientist population.

So, who are these natural scientists? The 58 natural science reviewers were almost all trained in natural or physical sciences, such as: ecology, biology, geology, engineering, etc. Among the exceptions to this rule, five of them worked in extension, two were policy analysts and two were watershed organization directors. Thirty-five of the 58 reviewers were associated with 4-year colleges or universities; the other 23 involved a mix of government, NGO and private organizations.

In terms of the questions regarding "why," "what" and "how," the most noteworthy differences between the two sets of reviewers come in the discussion of how organizations like the Collaborative can foster the integration virtually all members of the sampled population agree should occur. Two of the six reviewers implied that the focus on the collaborative process was overdone.

> Not sure you need the collaborative reviewers if the RFP is tight. The NERRS should make their problems clear and the science should gather data to solve those problems.

> It's better if you can pick people who can do both [applied science and collaborative processes]. I don't think there are any more ivory tower scientists; we're all doing collaboration. What if you have two people who love the collaborative process and the science people don't love it. Should the proposal move forward? Not if the science is weak but if the science is good and the collabortative process is not, it should go forward and you should tell them how to fix the collaborative process. They just need a little extra help with that. I was concerned about the weighting for this reason.

The second quotation is especially important because it expresses a view that we have encountered from many different people since we broached the idea of putting process on an equal plane with the scientific product. Often, people are very willing to converse about the importance of collaboration and integration, but they react strongly against the notion that quality science should be weighted equally to the collaborative process.

Moreover, I cannot agree with the idea that the collaborative process reviewers may not be necessary in the review process. Without a doubt, this would have resulted in much less criticism of the collaborative methods. Table 7.4 shows that of the 244 negative comments tabulated, 187 of them (77%) came from the collaborative process reviewers. These comments point to another interesting aspect of this comparison of two sets of reviewers from two different worlds. Two out of six applied science reviewers (33%, albeit of a very small sample size) were not convinced of the need for their collaborative counterparts. In contrast, none of the collaborative reviewers expressed the opinion that the applied science component wasn't necessary.

This lack of awareness or respect for the other sector's expertise arose in another aspect of the review process. Both the applied science and collaborative process peer reviewers were invited to comment on all the criteria, not just the criteria that corresponded to their expertise. In going through the peer reviews, we noted that, quite often, the collaborative process peer reviewers either declined to comment on the applied science methods, or they included a caveat such as "…but this isn't really my area of expertise." In fact, of the 29 collaborative peer reviewers, 12 of them (41.3%) made that choice. On the applied science side, only 1 of 58 reviewers (1.7%) made an analogous comment. This also suggests that one group of reviewers has a much greater awareness of the other group, or at least a greater respect for their singular knowledge on a certain subject.

Some of the comments from the collaborative process peer reviews seemed to be a reaction to this lack of awareness, which they perceived in the way certain proposals were written.

> In this regard, the proposal shows no understanding of the literature on collaboration, the barriers to collaboration, or a specific method to undertake a meaningful collaboration with a broad range of stakeholders. A great deal of research has been done on this, but the PIs appear to be unaware of it. (Imagine if the reverse was true, with social scientists proposing a well articulated collaborative process and saying that science will inform it, without showing any knowledge of the science. Would this be funded? I assume not.)

> Yes they have a study likely to be fine when it comes to understanding and applying the natural science developed in this project if the only people involved in the project and implementation were natural scientists. The crippling problem here is the lack of attention and understanding of social science and the collaborative design, process and leadership literature.

One heartening result from the interviews was a clear interest on the part of both kinds of peer reviewers to learn more about how the other side saw the proposals. As noted earlier, three of the six collaborative process reviewers suggested that the peer reviewers not write in a vacuum but rather have a chance to hear the other perspective. Two of the six applied science peer reviewers echoed this sentiment. In fact, the quotation below is from the same reviewer who noted that there are "no more ivory tower scientists."

> I would like to see the results of your RFP process to see if I was off. I'd like to know if my opinion was similar to the other peer reviewers and compare the collaborative reviews with the [applied science] reviewers.

This feedback suggests that, while biophysical and collaborative process experts may see the world in very different ways, there is a willingness to learn from each other.

6 The Packard Foundation: Compare and Contrast

At the outset of the article, I introduced the central problem of how funding organizations can respond to numerous calls for change by better braiding the rope (see Fig. 7.1). In order to address that question, we used the analysis of our RFP and review process to better understand why collaboration adds value, what collaboration consists of, and how funding organizations might begin to put ideas into practice. The salient ideas from our analysis of peer reviews and peer review/program manager interviews can be found in Table 7.5.

Breaking down what is meant by an appropriate process is critical because the funding organizations that have been the target of many injunctions to change can be broken down into three general categories: (1) those who are making significant efforts to change; (2) those who don't think change is really necessary; and (3) those who think they've made the appropriate changes, but perhaps have not. In some respects, this last group warrants the most concern, for two reasons. They create the false impression that efforts are underway to address identified gaps. Secondly, if they are not aware of best practices, a failure on their part can be attributed to the theory, when in fact the fault could lie with the implementation.

At the beginning of this chapter, I laid out a simplistic mental model with two options for addressing the principles prescribed in the "Informing" report: Option (1) Ask for teams of information producers and decision makers to submit plans to work together…and then use a separate step – after the review stages – to bring process experts into the picture. Option (2) Ask for teams of information producers, decision makers and process expert – all up front – and review the proposals according to the evidence that they can balance the information production side with the process requirements side.

Table 7.5 Synopsis of lessons learned from peer review

Why conduct collaborative science?
– More science links to decision making
– More interactions between producers and users of knowledge leads to a society that is more capable of living sustainably
What constitutes collaborative science?
– Detailed plans, created by experienced practitioners with specific training, to create an environment in which producers and users learn from each other
– Learning occurs at every step of the research process…including the problem definition stage
– Interactions are planned so that they acknowledge any values-based, socioeconomic and other barriers that can prevent the science from being used
How should funding organizations foster collaboration?
– Involving different disciplines in the review process is a must
– Efforts should be taken to allow reviewers and panelists with different perspectives to learn from each other

Note: The above process needs to take into account the possibility that natural and social scientists as well as collaborative process experts will see the world in very different ways

You have just read a case study implementation of Option 2, which has potential advantages and disadvantages. As alluded to earlier, the NERRS Science Collaborative shares its theory of change with the Science and Conservation Division of the Packard Foundation, a private philanthropic organization based in California (Packard 2010). Like the Collaborative, Packard invests in projects of up to 3 years, and, like the Collaborative, Packard began a new approach to funding research in 2009. Packard plans to continue on its chosen course for several years before taking stock, assessing gains made, and determining how to adaptively manage its program in the future. In contrast to the Collaborative, however, Packard has gone with Option 1.

(I am grateful to Kai Lee of the Packard Foundation for the time he took to discuss the ideas below with me).

Rather than attempting to frontload its projects with process experts, the Packard foundation instead is using a much more iterative approach with its grantees. Packard works with applicants to make sure that the team involves both information producers and the appropriate decision makers, and that some effort has already gone into learning about the needs of those decision makers. Packard then works with the applicants to collaboratively establish expected deliverables, depending on the goals of the project. Packard has created a template of "elements" and "questions to guide monitoring" as part of its "Linking Knowledge with Action" strategy (Packard 2010). For example, one of the elements relates to the joint production of knowledge. Potential monitoring questions within that element include: "Does knowledge process secure effective collaboration from decision makers, stakeholders, and researchers?" "Do potential users believe that the information process took account of concerns and insights of relevant stakeholders and was procedurally fair (Legitimate)?" Significantly, Packard builds into the process funding gates that allow it to terminate funding if it is shown that the research team is unable to achieve the collaboratively established milestones.

With regard to process expertise, this is something that Packard can introduce as is appropriate as the project matures. This can either be done through outside contractors or through Packard's program officers. In either case, Packard strives for these process people to be accountable to both the research teams as well as the funders. This joint accountability of third-party "integrators" or "boundary spanners" has been found to be critical for linking knowledge with action in that it avoids the common problem of the integrators being "captured" by either information producers or users (Clark 2008).

From our perspective, the approach being tried by Packard has many attractive elements. It is possible that the potential disadvantages of the Collaborative's approach could be avoided with the Packard paradigm. The most significant potential disadvantage is that some or all of the seven funded projects – though they were reviewed most highly within their cohort of proposals – may still not be strong enough with regard to collaborative processes to have a net positive impact on the intended users. How could this happen? Although we hope this is not the case, it is possible that the Integration Leads for some of these projects are not sufficiently experienced – or enabled by the rest of the team – to manage the process sufficiently well. After all, this is a new and innovative approach to applied science. We have seen – and other funding organizations have also seen – instances in the past where applicants succeeded in writing convincing proposals but then were either unable or extremely challenged to implement their planned activities. As noted by one of the collaborative process reviewers, a poorly planned and implemented collaborative process can be worse than no collaborative process at all.

Another disadvantage relates to the joint accountability discussion above. The role of the Integration Lead in our process is to balance the perspectives of the different actors in the system. But powerful personalities can easily overwhelm an Integration Lead, which is a newer and less understood role than the traditional principal investigator (Clark 2008). It could be that the Packard model is a more effective way to mitigate traditional power struggles that occur in research endeavors.

Another potential disadvantage is that relying on process experts is risky if different parts of the country seem to have a greater abundance of them than others. A scientist from the Gulf of Mexico asked me for help in finding someone with experience in overseeing a collaborative (participatory) process. After several hours on the Internet and several calls to other collaborative process experts, I was only able to turn up one person within a 2 h drive of the scientist's lab. (In contrast, the Great Lakes and areas in Canada seem to have almost an over-abundance of collaborative process experts). I then spoke with an extension agent from one of the Gulf states, and described the type of person I was looking for. He replied that extension agents could certainly help with the on-the-ground facilitation and connection to decision makers. However, with regard to someone who could direct the whole process more holistically, he was less able to help. He also noted that the kind of people I was talking about tended to make intended users a little uneasy, as if they were study subjects rather than people. Ideally, he noted, the collaborative process team would have a holistic person in the background and an extension-type (or NERRS coastal training program coordinator) as the familiar face of the project.

A final disadvantage is the risk that the process burden involved in our approach may intimidate and scare off applicants, and these could be applicants with strong relationships with decision makers as well as a track record of producing highly credible scientific information. We have seen some evidence of this "intimidation" happening within the Reserve systems; some potential applicants read our RFP and elected not to pursue funding because they found the process difficult and/or alien. In contrast, such applicants could find the Packard approach more welcoming in its incremental and iterative introduction of the process deliverables.

Of course, there are potential advantages to the Collaborative's approach as well. If proposals are diligent in bringing together the proper resources and expertise early, projects will get off to excellent starts, with problems being clearly and collaboratively established with the appropriate stakeholders at the proposal stage. As discussed earlier, getting the problem right is critical. The famous statistician Tukey is quoted as noting, "Better a poor answer to the right question than a good answer to the wrong question." The importance of getting the problem defined collaboratively is also stressed in many of the NRC reports on creating decision-relevant knowledge (e.g., NRC 2006, 2007). In addition, interactions will waste no time establishing good working relationships between project investigators and target audiences, increasing the relevancy and legitimacy of the research (Cash et al. 2002, 2003).

Another potential advantage is simply the opposite side of one of the disadvantages: the risk of being thrown into the deep end of the pool. Yes, one may sink, but one may also get some good practice swimming. Because of the shortage of funding for applied science, we have seen some teams take on the challenges associated with building interdisciplinary teams – including process experts – despite considerable reservations. Before awards were announced we heard from several teams that they had seen tangible benefits that would have lasting impact…even if their proposal was unsuccessful. For example, one staffer at an East Coast Reserve noted that, since the release of the RFP, the Research Coordinator and the Coastal Training Program Coordinator had greatly improved their working relationship and had already collaborated on other proposals as a result. In addition, we have heard from several natural scientists that, since working on collaborative projects (including previous RFPs), they have changed their attitudes regarding the involvement of facilitators and collaborative processes in general. One research coordinator noted, "Natural scientists may not enjoy these collaborative processes, but they do enjoy seeing their science get used more." (J. Fear, 2010, personal communication).

Finally, we have seen a significant increase – from all sectors in the Reserves – in requests for information regarding collaborative processes, since the release of this RFP. Below are two of many quotations regarding the influence of the NERRS Science Collaborative on attitudes regarding integrating natural and social science within the Reserves. These quotations come from survey and interview work implemented as part of a dissertation project (Robinson 2010).

> The NERRS Science Collaborative is really going to help going a long way toward breaking down some of those barriers where people can start to see the benefit of integrating the social sciences and natural sciences

> So, if the RFPs that are put out request that you need to incorporate social science, that probably is going to happen because otherwise you're not going to get funded....that definitely has influence of how you plan or conduct your research…that's something we've seen within the NERRS system now with the science collaborative.

Of course there are more ways to braid the rope than the ones exemplified by the Collaborative and Packard. One hybrid approach between the two extremes is to have the process reviewers make concrete suggestions to the funders as to how much continued oversight a project will need to adequately deal with process issues (P. Stern, 2010, personal communication). Also, as we have discussed, some NSF, NOAA and other programs are implementing innovative approaches to better linking science with action. For example, a program within NOAA called CSCOR (Center for Sponsored Coastal Ocean Research) tasks their program managers to work with project investigators to set up "management advisory groups," which make suggestions on how to modify and package scientific activities to maximize research utility. This requires a great deal of effort on the behalf of program managers (E. Turner, 2011, personal communication). For more information on other innovative programs, see the "Informing" report, to which we will now turn our attention in a more focused manner, in order to put the lessons learned from this study into a broader context.

7 Adding Empirical Resolution to NRC's Guidance

The goal of this chapter is not to determine one superior paradigm but rather, through the analysis of the Collaborative's RFP as well as the comparison with the Packard approach, to add some pragmatic granularity to the principles that have been espoused by many reports and publications, especially the "Informing" report. Below, I go through each of the report's principles in turn and add corollaries related to how a funding agency might approach implementing the suggested ideal. This is not to suggest that the report is deficient. In fact, if all this chapter accomplishes is that more people read that report, especially Chap. 2, it will have been worth the ink and the paper.

Some might protest that the NRC report was written explicitly for climate change, and not all decision-relevant science is addressing that particular issue. True, but the issues that make climate change so challenging – e.g., scale issues, human values, dynamism of the problem – are common to most "wicked" problems (Rittel and Webber 1973) in which the cause and the solution involve the human dimension.

In reviewing the six principles below, everything in normal print is paraphrased from Chap. 2 of the "Informing" report. Everything in italics relates to lessons learned from our analysis.

1. Begin with user's needs

   - One-time, sporadic efforts DO NOT qualify.

     – *Our case study would seem to add that efforts—no matter how frequent the interactions—that are not well thought out, could also fail to produce the desired results.*

   - Relationships are key.

     – *This was confirmed in our independent case study.*

   - Communication must be two-way.

     – *Again, independently confirmed in our case study.*

   - Trust building should be a goal of the interactions.

     – *Our case study showed that having explicit goals for the collaborative process is sometimes neglected, especially when process experts haven't been consulted.*

- It is especially critical to define the problem collaboratively.
  - *For funding agencies, this is logistically challenging, with potential trade-offs associated with the Collaborative's approach—trying to build a full team, with process experts, from the beginning—as well as Packard's approach, which relies more on iterative guidance from the funder. Think carefully about this part of the process.*

2. Give priority to process over products

- Poorly managed interactions between information producers and users will decrease connections between science and decision making.
  - *Confirmed in our study.*
  - *There is confusion around who and where the experts are to help us avoid poorly managed interactions. As noted earlier, some folks in extension and Sea Grant have the skills, but some of them do not. Also, some parts of the country may seem to be more rife with these practitioners than others.*
  - *The good news is: these people are out there. The bad news is: they may be underutilized and, as they become more utilized, we may find as a society that we need more of them.*
- Dedicated time and expertise within the research project are required.
  - *See above.*
  - *May want to consider contingent funding, establishing clear deliverables and striving for joint accountability for the integrators.*
  - *Plan and prepare for resistance to the process emphasis. Our case study points to the possibility that many in the scientific community do not see the need for process expertise.*
- Develop a culture of learning among participants.
  - *This point can cause confusion in an agency's strategic approach. As shown earlier, some may interpret "decision-relevant knowledge" as meaning that the research was used to support one decision, and maybe even one decision maker. Another perspective is to maximize relationship building and learning through the conduct of the research. These are important distinctions and would have important ramifications for how RFPs are written and metrics established. Make sure your colleagues are on the same page with regard to this.*
- Leadership is critical.
  - *Power in a research project is often left unaddressed. We tried to address it with an Integration Lead; Packard addresses it through continued involvement and joint accountability of certain team members. This requires careful consideration, especially given the history of science policy in the United States (Stokes 1997), which has been discussed in other chapters in this book.*

3. Link information producers and users
   - Boundary organizations can be helpful in bridging different disciplines.
     - *Our study certainly found evidence of silo-based thinking getting in the way of producing decision-relevant science.*
     - *Again, does one try to build the boundary spanner into the competitively granted projects or put more resources into managing the process from the funder side?*
4. Build connections across disciplines and organizations
   - It takes time and care to collaborate between scientific disciplines, between funding agencies, between information producers and users. Yet if we don't take these steps, the science will have less chance of linking to decision making.
     - *Addressed earlier.*
   - It is also important to build connections between scales, so that national assessments and research can be made relevant at the local level and vice versa.
5. Seek institutional stability
   - Collaborations take time. This doesn't require institutionalization of new efforts, but that can be helpful.
     - *As noted earlier, we have seen reports that Reserves are adopting the approach of "always collaborating" so that they can take advantage of RFPs when they arise.*
   - Extension funds provide some resources and institutional stability.
     - *We have found this as well although the familiarity with collaborative process methods varies from place to place. In some cases, resources and personnel may need to augmented, or existing personnel may seek additional training.*
     - *As part of the Collaborative, the University of New Hampshire is piloting a new curriculum to train Masters students and full-time professionals in the skills required to direct a collaborative process.*
6. Design processes for learning
   - Points in this section have been addressed above.

8 Conclusions

This chapter has presented qualitative research data on the subject of applied research in our science funding agencies. It is my hope that some program managers who have been seeking explicit advice on how to improve how they foster decision-relevant science will find helpful material within these pages. No doubt, some program managers will read this chapter with a healthy dose of skepticism. As well they should. This is one case-study, after all, and generalizing observations from one case study to other contexts must always be done with caution, whether the research is qualitative or quantitative. Some may react that this paper is full of subjectivity. Although I have tried to present alternative theories and explanations, I have to admit to my bias; there is no doubt about that. In 2005, after 7 years of funding applied science, what I saw was that highly credible work was simply not being used because we had ignored issues related to relevance and legitimacy (Cash et al. 2002). Yes, I know that research impacts are famously difficult to track and it may take years before seeds of knowledge begin to sprout results (Tornatzky and Fleischer 1990). However, our program and many other programs like it are not only meant to solve the problems decades from now. Much of our research is actually supposed to help create solution alternatives in the near future. It is with respect to that aspect of our mission that this chapter is addressed.

I close by again asking: whether you agree with the assumptions in this chapter or not, why is so much good science not being used by decision makers? And why have we been so slow at the national funding agency level in changing our culture? Is it because our natural science and engineering products aren't good enough? I think we have to admit that it is possible that some of the questionable assumptions we saw in our study – relating to how science leads to decision making and what expertise must be engaged to produce decision-relevant knowledge – exist not only within academia and other stakeholder groups, but also within the relatively small cadre of scientists and policy makers who set science and policy strategies in this country. If that is true and if left unaddressed, it may be difficult to improve our theory of change and the way dollars are allocated to address environmental challenges.

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Part III
Politics and Policy (Governance and Frameworks)

Chapter 8
Introduction: Natural Resource Management – Framing Governance Challenges

Lynn Scarlett

In 1969, six miles off the coast of Santa Barbara, a blow-out at an offshore oil-drilling platform spewed crude oil into the sea and onto shores. I joined volunteers to tend birds coated in oil. Some survived; thousands died. A few years earlier, Rachel Carson's *Silent Spring* described a natural world in peril from the chemical potions intended to stamp out malaria, improve crop yields, and, generally, serve mankind. Together – a book and an event – form the foundations of America's modern environmental policy journey. During four decades, that journey has unfolded in fits and starts, with an accumulating toolkit and an evolving narrative. That narrative began as a series of wake up calls. It developed into a basket of statutes – the National Environmental Policy Act, the Clean Air Act, the Clean Water Act, the Endangered Species Act, and others. It matured – and debates unfolded.

Round one in these debates, predictably, pitted economy against the environment as political antagonists argued the merits – and, even, constitutional appropriateness – of federal action. In round two, many participants accepted the relevance of federal action to protect the environment but tangled over the toolkit. Were command-and-control regulations that prescribed specific actions effective and efficient? Could market-based tools – pollution fees, tradable pollution credits, stronger liability rules, and so on – do a better job? We have entered round three in this journey. The old narratives have not vanished. But an additional plot is unfolding. That newest element is one of adaptation and collaboration among scientists, decision makers and the public juxtaposed against linear and fixed solutions developed among a circle of technical experts.

The chapters in this section probe this storyline. Why are collaboration and adaptation relevant to the environmental challenges of the twenty-first century? What *is* adaptation? How do concepts of collaboration transform into governing practices

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and decision-making settings? What are the relationships of scientists (experts), policy makers, and the many "publics" who, increasingly, participate in collaborative decision making about lands, waters, and wildlife?

As the authors in this section probe these questions, key themes recur. These include the complexities of the problem set: Nature is dynamic, nonlinear, and interconnected. "Scientists," write Kathi Beratan and Herman Karl in Chap. 10 ("Managing the Science-Policy Interface in a Complex and Contentious World"), "have increasingly recognized that disruptions to one element of the global social-ecological system can reverberate throughout the system in surprising and potentially catastrophic ways." Problems, they note, "are highly interlinked and complex, which limits our ability to decipher cause-effect relationships." Stephen Light and Jan Adamowski, picking up the theme of interconnectivity and complexity in Chap. 13 ("Flow in the Everglades: The Game Inside the Game"), point to a cognitive challenge of "tearing down the imaginary vials that entomb our past and deny access to the future." They describe a cultural 'blind spot' that "is our almost subconscious and instantaneous separation of objects from relationships embedded in experience. The centrifugal force of our cognitive powers tends to rip the rich mosaic of reality, separating its interwovenness."

People, too, behave in dynamic ways; participants change. Newcomers arrive with new values. Daniel Hogendoorn, David Laws, Dessie Lividikou and Arthur Petersen, writing of water management in the Netherlands, describe the interaction of scientists and policy makers as unfolding in a context of ever-emergent knowledge and new actors. "With new actors," they note, "values change, as well as the status of what is known." They describe the decision-making dilemmas such evolution educes: "From one perspective, changing values and changing status of technical knowledge open up knowledge-development and produce a wealth of insights…. From another perspective, searching results in an impenetrable cloud of expertise that produces new uncertainties by continuously recombining and pruning expert knowledge."

Knowledge is, inevitably, incomplete. Uncertainties percolate. For example, the effects of a changing climate, broadly understood in general terms, unfold with devilish details at the regional and local scales – and we do not wholly understand these details. Yet it is these details that often matter to a neighborhood, a community, a city, a natural resource manager.

Relevant knowledge is complex. It is dynamic. It is also many faceted and includes the knowledge of those with "boots-on-the-ground" professional experience. Such knowledge helps to illuminate the details of place and identify what's practical. Hogendoorn et al. describe nine practitioners within the context of Dutch water management whose work ranges from mathematical modeling of waves and subsoil conditions to dike inspectors who must implement the decisions of policy makers. Why, ask the dike inspectors, must they tangle with complex measurements and formulas? Why can they not simply watch the water rise (or fall)?

Natural resource management involves more than a dispassionate assembly of scientific, technical, and practical knowledge. Fundamentally, resource management decisions – whether in the context of a changing climate, a major restoration project, or public lands management – affect people, their values, their livelihoods, and their communities. In Chap. 9 ("Transcending Boundaries: The Emergence of Conservation Networks"), I suggest that "Identifying enduring outcomes inherently involves questions of values, priorities, and place. Thus, a persistent challenge for resource managers and communities is how to provide a rich context for expression of individual values and a means of generating management options acceptable to people with competing priorities."

The significance of values, and how decision processes give expression to these values, brings particular relevance to Chap. 12 ("Values in Natural Resource Management and Policy") by David Mattson, Herman Karl, and Susan Clark. These authors offer a definition of "values" and distinguish values from needs, preferences, attitudes, and interests. They define values as physical and psychological indulgences that people seek or desire and note that "people seek values through institutions using resources." Using the case of the Glen Canyon Adaptive Management Plan and associated decision making, they then discuss how institutional design can have a significant effect on how fully values are expressed and on decision making power, respect, and outcomes.

As many authors in this book suggest, healthy ecological systems are fundamental to human well being. But, on landscapes inhabited by people, achieving and sustaining healthy ecological systems involves relationships – sustainable relationships of people and place. Stephen Light and Jan Adamowski examine those relationships as they have unfolded over many decades in the Everglades. Theirs is a personal, passionate, and probing account in which they describe ecological restoration as "a process of creative emergence that lies beyond our ability to direct or command." They critique decision processes characterized by a "quest for certitude and the propensity to resort to unilateral power," a term they apply to the imposition of a dominant interest – for example, urban needs for water supply and flood control – on resource management decisions.

Light and Adamowski offer a case study situated within a larger philosophical exploration of the relationship of mankind and Nature; the idea of emergent knowledge; and the importance of the capacity to evolve in a context that is ever-changing. They perceive the central governance challenge as one of transitioning from project-centric management in a context of unilateral power to one of "evolutionary design." Evolutionary design, as they describe it, is not a variation on adaptive management. Adaptive management, a centerpiece of much discussion throughout this book, builds upon a perspective of the ecological world as dynamic and complex and our knowledge as uncertain. Given those characteristics, adaptive management introduces experimentation, monitoring, and evaluation of results against previously identified goals. But adaptive management, at least as practiced, still unfolds on a project-centric basis and often within an "efficiency" framework that Light and Adamowski critique.

I come full circle back to issues of collaboration. As Herman Karl, et al. point out in Chap. 15 ("Adapting to Changing Climate: Exploring the Role of the Neighborhood"), "action requires agreement about the nature of anticipated problems and motivation to address those problems. Achieving that agreement and motivation lies at the intersection of science and politics." Fundamentally, governance structures, institutions, and processes affect how that science and policy dialogue plays out.

Mariam Merad, N. Dechy, and F. Marcel describe a decision by the French government to launch a highly collaborative decision making framework within which to identify climate adaptation options. They situate this case study within a broader examination of participation. What does public participation mean? Merad et al. present a continuum of participatory models anchored at one end by the long-familiar construct of representative democracy, with citizens selecting representatives who, in turn, make decisions in their behalf, to what Merad et al. refer to as "deliberative democracy," in which the public (or relevant stakeholders) are involved throughout the decision-making process and influence final decisions. In my chapter on "transcending boundaries," I describe other emergent forms of shared (network) governance in which multiple participants engage in something akin to "deliberative democracy."

At root, collaborative conservation springs from a growing attempt, as Karl et al. point out in Chap. 15, "to incorporate the views and knowledge of multiple stakeholders" in natural resource management decision processes. Light and Adamowski, examining the Everglades with its many value-laden conflicts, note that the search, within such a context of multiple values, is not "for mediocrity, compromise, 'just getting by,' or even for 'he who gets the gold.'" The search, they write, is "for composite solutions…that order, reconcile, and mutually reinforce 80–90% of the conflicts," while leaving decision space for addressing remaining (and emergent) "constraints, uncertainties and divergences." Light and Adamowski sum up what is, perhaps, the essential theme of all the authors as they probe issues of adaptation, collaboration, knowledge-building, and sustainability: "The search is for excellence."

Chapter 9
Transcending Boundaries: The Emergence of Conservation Networks

Lynn Scarlett

Abstract Over the past century, public land management has unfolded as a saga of tensions and challenges at the delicate interface of people and place. Many of these challenges test the endurance of our governing institutions. An institutional discovery process is unfolding with the emergence of new forms of governance – the rules and processes by which formal and informal groups of people make decisions regarding matters in which they have intersecting responsibilities and interests. Networks, collaboration, shared stewardship, and partnerships characterize these new forms of governance. These emergent collaborative endeavors are creating new bundles of ownership rights through easements, contracts, compacts, and cooperative agreements. Lying as a backdrop to the emergence of these new forms of governance are four policy and decision making puzzles. These include information challenges, incentive challenges, accountability challenges, and coordination challenges. Examining examples of network governance illuminate how they address these four decision making challenges and their implications for law, policy, and management skills.

Keywords Network governance • Shared governance • Collaborative conservation • Science and decision making

Over the past century, public land management has unfolded as a saga of tensions between private decisions and public directives. That saga involves a delicate interface of people and place and of human hands on landscapes. Conservation challenges lay at this interface of people and place, involving a difficult balance between public and private spheres of action.

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Many of these challenges test the endurance of our governing institutions and present environmental conundrums that complicate the quest for healthy lands, communities, and economies. Consider just one location – the Everglades in Florida (NRC 2003, 2007, 2008; Committee on Restoration 2005). The Everglades landscape reflects decades of altered water flows resulting from century-long efforts to minimize floods and open up agricultural opportunities on these lands. Compounding the changes in water flows are water quality problems that result from years of discharge of chemicals into Everglades waters from agricultural activities to the north. With these changes in water quality and water flows, the Everglades "river of grass" is a transformed ecosystem. Areas that were once wetlands are often now dry, causing changes in vegetation, loss of wildlife habitat, peat subsidence, and other impacts. Rising sea levels now threaten to increase salinity levels of inland waters, a process exacerbated by low freshwater flows in this highly altered landscape.

To reverse this transformation, the United States has embarked on a multi-billion, multi-year, multi-agency effort to restore hydrological flows across a portion of the Everglades and to improve water quality. But such changes require altering decades-long agricultural practices; re-flooding some areas in which buildings, over the years, had been constructed; removing canals and modifying infrastructure; and altering some land uses. These actions require coordination among the U.S. Army Corps of Engineers, National Park Service, U.S. Fish and Wildlife Service, South Florida Water Management District, Florida Department of Environmental Quality, Florida Department of Transportation, other state and federal agencies, and the Miccosukee Tribe. Decision making involves generation of information and scientific analysis from the U.S. Geological Survey and other scientists and inputs from stakeholders that span recreational, farming, environmental, and urban interests.

How, then, can Everglades restoration proceed in a coordinated way, involving multiple agencies and public and private participants? How can restoration unfold while enabling century-old communities still to maintain their homes, their cultures, and their livelihoods?

Similar complexities unfold across the nation in the dynamic interface of people with the lands. Where might ranchers graze their cattle? Or, where might businesses cut timber for homes, access energy to warm houses, or extract minerals that transform into toothpaste, pacemakers, our wedding rings, or computers? And who should decide? Some natural resource issues span multiple jurisdictions. Restoring these ecosystems – in the Chesapeake Bay, the Bay-Delta of California, the Gulf Coast of Louisiana, and elsewhere – require coordinated action over many decades and the involvement of agencies as well as citizens.

Natural resource managers, both public and private, face a tapestry of rights, ownerships, and distributed responsibilities. Some places involve private ownership of lands but public ownership of mineral rights. Other places involve vast stretches of public ownership interrupted by centuries-old in-holdings of private property. Some public lands, by law, are set aside for resource use; others, like national parks, are designated for preservation and enjoyment of the public. Multiple agencies – federal, state, tribal, and local – have intersecting and overlapping responsibilities, yet decision structures segregate rather than link decision makers across these agencies (McKinney et al. 2010).

1 Lands in Transition

Public lands hold a prominent place in this tableau. The U.S. Department of the Interior manages over 500 million acres, or one in every five acres of the United States, including 552 wildlife refuges, 392 national park units, 260 million acres of multiple use, public domain lands, and 1.7 billion acres of outer continental shelf. The U.S. Forest Service manages over 193 million acres, and the Department of Defense manages another 30 million acres. Methods and processes for managing these lands are in transition, with several phenomena driving this transition.

First is urbanization and related land use changes. Through that urbanization, once remote rural lands, including public lands, are now adjacent to large urban populations as broadening rings of suburbs expand existing cities into the countryside. Over the past five decades, migration from cities outward to the countryside tripled the amount of land now making up suburbia (Ball 1997). Where land managers in the West once may have encountered an occasional rancher, they may now see 1,000 off-road vehicle users in a single hour. Public lands now attract over 400 million recreation visitors each year, more than the entire U.S. population.

The second phenomenon affecting natural resource management is the evolving nature of land management challenges. Those challenges are evolving from site-specific problems to landscape-scale issues. Nature itself knows no boundaries. Fire, water, and species all present management requirements that extend beyond lines on a map or the ownership patterns of land deeds and fee simple titles. The effects of a changing climate, such as changes in precipitation patterns, sea level rise, and shifts in wildlife ranges, unfold at varying scales unrelated to land ownership boundaries and agency jurisdictions (Scarlett 2010). A central governing question becomes that of how to coordinate human action across jurisdictional boundaries, both public and private, over a sustained timeframe.

The third trend driving the transition in resource management, conservation, and governance is a growing appetite for cooperation. After decades of litigation and deep conflict, growing numbers of communities, conservation advocates, and resource managers have turned to collaborative, on-the-ground problem solving (Wollondeck and Yaffee 2000; Brick et al. 2001; Brunner et al. 2002; Koontz et al. 2004).

1.1 Network Governance – Experiences in Shared Governance

New relationships between public and private organizations and landowners are resulting from these three trends. An institutional discovery process is unfolding with the emergence of new forms of governance – the rules and processes by which formal and informal groups of people make decisions regarding matters in which they have intersecting responsibilities and interests. Networks, collaboration, shared stewardship, and partnerships characterize these new forms of governance.

These governance models are blurring the distinctions of public and private action and blending stewardship responsibilities into a shared enterprise. These emergent collaborative endeavors are creating new bundles of ownership rights through easements, contracts, compacts, and cooperative agreements. Lying as a backdrop to the emergence of these new forms of governance are four policy and decision making puzzles. These puzzles are not new, but they are gaining renewed attention in the context of merging forms of collaborative or shared governance.

The first puzzle – the information challenge – is how, in the context of land and natural resource management, to generate and use relevant information. Second is how to motivate conservation over time while maintaining dynamic economies and thriving communities – what might be called an incentives challenge. The third governance puzzle is how to address risks or harms imposed by some on others – the accountability challenge. The final challenge is how to achieve coordinated human action across ownership and jurisdictional boundaries – the coordination challenge (Ostrom 1992; Tang 1992; Ostrom et al. 1994; Goldsmith and Eggers 2004; Goldsmith and Kettle 2009).

These four challenges lurk as an often unstated set of organizational and decision making problems that face land owners, land managers, and policy makers.

2 The Information Challenge

Consider first the generation and use of relevant information to enhance decision-making, an implicit requirement of durable decisions. Informing decisions with what science can illuminate is important, indeed, critical to the ability to maintain healthy lands, communities, and economies.

Yet the interface of science and policy is complicated. That interface involves the complexity of nature itself in which multiple variables interact to affect outcomes, and managers face many tradeoffs. The Klamath Basin, for example, thrust that community into headlines that described acute conflicts over water, wildlife, and land uses. Though the Basin became a poster child for water conflict in the twenty-first century American West, resolution of the Basin's challenges could not be dictated from Washington nor crafted by scientists. Conflict resolution ultimately involved many players and many variables in protracted discussions over many years, culminating in a 26-party signing of a restoration agreement in 2009 (Klamath Agreement 2010).

The dialogue among participants unfolded in a context of competing values and purposes in the Klamath watershed in which farmers, power producers, fishers, conservationists, Native Americans and others vied for water supplies insufficient to meet all needs all the time. But scientific complexities also challenged participants in these dialogues. In 2002, an estimated 12,000–30,000 fish died, washing ashore. The die-offs occurred after the Bureau of Reclamation had reduced water flows to the Basin by 25%, a decision prompted by a National Research Council conclusion that scientific information was inadequate to support requirements for higher water flows to protect fish species under the Endangered Species Act (NRC 2004). Scientists agreed that the fish had died of "gill rot;" they disagreed regarding the role played by water flows, water quality, or other factors in causing the gill rot (McHenry 2003).

The science/policy interface is also rendered especially complex in the face of challenges that spring from ever-present change. Greek philosopher Heraclitus once wrote: "All is flux; nothing stays still." Nature itself is dynamic, particularly as the effects of a changing climate bring sometimes rapid changes. But human action is also dynamic and sometimes unpredictable. Science, too, is dynamic: knowledge is never final.

These dynamic circumstances make monitoring, adaptation, and resilient management options desirable. Resource managers must make daily decisions, often in a context of inconclusive, sometimes contradictory and ambiguous information. Ambiguity is sometimes compounded by fundamental limits on what's knowable about future conditions, whether as a consequence of the inevitable surprises of human action, or as a consequence of nonlinearities and the complexities described by chaos theory (Scarlett 2010; Hilborn 2004). Numerous tools can help managers improve decisions within a context of uncertainty, including scenario planning and various statistical methodologies. Yet challenges persist in introducing these tools into the setting of resource managers and policy makers. The ability to change course or adjust practices based on new information remains especially relevant in the complex settings of resource management.

Resource managers also face the complicating issue of defining the compass, scope and scale of the relevant problem. Is the relevant scope a backyard, a stream, a watershed, a continent, or a world? How should managers and policy makers draw appropriate boundaries for their decision focus? Who draws the boundaries? Answering these questions demands scientific insights, but these are as much questions of human communities, values, and social constraints as they are matters of scientific distinction and categories.

Another complication is that of communication, both across specializations and experiences. Michael Shrage, in his book *Serious Play,* describes problems of sharing knowledge when different professions speak different languages, and different academic disciplines use different vocabularies and different analytic frameworks (Shrage 2000).

Finally, the most notable challenge in any interface of science and policy pertains to the context of policy, which is fundamentally about values. Policy makers ask, "What values do we care about?" "How safe is safe enough?" and "What are our priorities, and how should those priorities affect decisions about spending time, effort, and dollars?" Scientists ask: "What is reality? How does the world work?" "What is" is not the same as "what do we care about" or "Where do we want to go?" (Scarlett 2010)

This value orientation suggests that sustainable outcomes don't spring merely from getting the facts straight and getting the science right, but rather, enduring outcomes are those deemed acceptable to individuals and communities within the constraints and conditions established by laws and regulations. Identifying enduring outcomes inherently involves questions of values, priorities, and place. Thus, a persistent challenge for resource managers and communities is how to provide a rich context for expression of individual values and a means of generating management options acceptable to people with competing priorities.

At the intersection of science and policy, these challenges are giving rise to new questions about the relationship between science and policymaking. The U.S. Geological Survey and others have experimented with joint fact-finding collaboration in which scientists, citizens, and decision makers jointly define the purposes, scoping, research design, and uses of technical and scientific information to enhance decision making (USGS 2004). At Tomales Bay, California, for example, pathogens, nutrients, sediment and mercury have impaired the bay and Lagunitas and Walker creeks. Testing showed poor water quality, resulting in human advisories. Human disease outbreaks stirred the communities into action, resulting in formation of a Tomales Bay Watershed Council in 2000.[1] The Council established a process for joint fact-finding, enabling participants to integrate science with collaborative planning. In a departure from more traditional relationships between the science community and collaborative resource management efforts, citizens worked alongside scientists to help define what issues were of interest and to help formulate the scope and types of information gathering and analysis. Prior to that collaboration, various interests with competing perspectives on the causes of poor water quality had presented competing data and competing analyses. The joint-fact finding process assisted the communities in better understanding the nature of the science needed to address their questions and the research protocols required to produce rigorous results. The collaborative process helped the community overcome "data battles" and center on problem solving.[2]

The Tomales Bay experience affirms the results of research regarding the role of science in decision-making. This research indicates that methods that link researchers to users, include information dissemination efforts, and provide for adaptive research outputs are keys to good information flows and uses of knowledge. The user interaction with scientists can affect whether and how scientific and technical information are used, with mere reception of information by users not implying that they will use it (Landry et al. 2001, Lawton 2007).

3 Governance Challenges

These observations bring me back to the four decision-making puzzles delineated earlier. Having very briefly explored the issue of information generation and use, consider the other three issues of incentives, accountability, and coordination. All three pertain to how decision makers, both public and private, make

[1] Cooperative Conservation America web site: http://www.cooperativeconservationamerica.org/viewproject.asp?pid=490. Accessed 29 Aug 2010.

[2] Communication with the author, 2002.

choices, communicate information and ideas, and organize and coordinate action. Fundamentally, these are governance challenges. To understand their intrinsic importance to the discussion of lands, communities, and conservation, several examples are instructive.

3.1 Buffalo Creek, Pennsylvania: An Informal Partnership

Buffalo Creek in western Pennsylvania has numerous farms with beef and dairy cattle. Lands are largely privately owned. Historically, cattle have wandered the landscape and walked through the streams at will. Through a non-regulatory program, the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program, farmers are now engaged in stream bank fencing. The fencing keeps cattle out of the streams, which allows trees and brush to regenerate and protect the banks from erosion.[3]

New vegetation provides shade for the stream that lowers its temperature, making it more hospitable for fish and other fauna and flora. The stream bank shrubs once again host ground-nesting for birds and other animals. Farmers have put vernal pools in place and built barn owl boxes, wood duck boxes and bat boxes. In partnership with Pheasants Forever, a bat protection association, Ducks Unlimited, local universities, and federal agencies, farmers are now moving cattle out of streams. The fencing also enables farmers to practice some rotation grazing and, with cattle no longer entering the stream, reduces the bacterial count in the stream. The result is healthier cows, less waterborne hoof disease, and fewer spontaneous abortions during the calving season that had resulted from waterborne diseases.

At Buffalo Creek, the public-private conservation partnership is both enhancing accountability by engaging farmers in reducing pollution and strengthening coordination among landowners that share a watershed. The Buffalo Creek stream bank fencing blends public and private actions and involves formal and informal governance, shared goals and partnered problem solving.

The setting at Buffalo Creek involves many miles of streams that trace through multiple privately owned farms, and several agencies. The U.S. Fish and Wildlife Service, USDA Natural Resource Conservation Agency, the Washington County Conservation District, Pennsylvania Game Commission, Pennsylvania Department of Environmental Protection, and a number of other agencies and nonprofit organizations, along with some 50 landowners, all partner in the restoration effort that covers over 107,000 acres.[4]

The collaborative relationship at Buffalo Creek is an informal one that does not involve new governance structures. It does, however, involve creative mechanisms to coordinate action. California University of Pennsylvania acts as the landowner

[3] The information presented here on Buffalo Creek, Pennsylvania comes from an author site visit in 2002.

[4] See the Cooperative Conservation America web site at: http://www.cooperativeconservationamerica.org/viewproject.asp?pid=127. Accessed 29 Aug 2010.

agent, constructing projects using 75% U.S. Department of Agriculture cost-share funds, with nonprofit organizations and landowners providing the remainder. Other agencies and nonprofit organizations provide technical and in-kind support.

3.2 Ducktrap River, Maine: Coordination Through a Land Trust

A different sort of partnership is unfolding along the Ducktrap River in Maine. One of eight rivers remaining on the Atlantic coast that host Atlantic salmon, the Ducktrap River is experiencing erosion, loss of habitat, and encroachment of non-native plants. Along the river, there is a mosaic of private and public ownership, factories, farms, cities and towns. The partnership includes people who use the adjoining lands for recreation, snow mobile enthusiasts, fishers, hunters, and conservationists.[5]

The lands along the river have many uses and face many challenges. To address these challenges, 28 partners on the river formed the Ducktrap River Coalition to work together to reinstall vernal pools by converting abandoned gravel pits. They are using new technology to put netting along stream banks to allow new grasses to flourish to re-anchor the river banks and avoid erosion. The Coalition has worked with a snow mobile association to find paths for that activity that will put the lightest footprint on the land. The Coalition is working with farmers to put easements on some lands to prevent land fragmentation that would otherwise imperil wildlife.

Like Buffalo Creek, this cross-jurisdictional, collaborative effort has not resulted in new formal governance institutions. Instead, a land trust (Coastal Mountains Land Trust in Maine) coordinates goal-setting and fundraising and provides staff to sustain the projects and the purposes of the coalition, using an annual budget of $30,000–$40,000. Though the direct dollar amounts are small in comparison to some large-scale conservation efforts, the coordinating structure represents an emergent model in which multiple public and private entities identify and implement shared resource management goals.

3.3 Malpai Borderlands Group, Arizona: Creation of a Grassbank

Across the United States, in the Malpai Borderlands along Mexican border in Arizona, are ranches that have been in the same family for four or five generations. Ranchers face periodic drought, erosion along streams, and, increasingly, threats from development that result in fragmented lands. The 1,250-square mile triangle of land within which the ranches operate is among the most biologically diverse areas

[5] Information is from a site visit by the author (2002) and from: http://www.doi.ogv/partnerships/ducktrap.html and http://www/coastalmountains.org/protecting_land/active_campaigns.html#ducktrap.

in North America. Private landowners hold less than three fifths of the land, with the states of Arizona and New Mexico, and federal agencies owning the remainder.

Ranchers in the Malpai region joined together to create the Malpai Borderlands Group, which partners with scientists, other nonprofit organizations, and public agencies.[6] The Group developed shared goals, projects to generate relevant scientific and other information, and a model of community decision-making through which participants work as partners to undertake actions to achieve their shared goals.

The Malpai Borderlands Group in some ways represents a traditional model of nonprofit governance. But two of its governance innovations are precursors to the sorts of more formal network governance models emerging elsewhere. First, the nonprofit organization coordinates action with the federal government and developed a Malpai Fire Map, fire management plan, and broader resource management plan alongside federal agencies. Second, the group created a new institutional arrangement, a conservation easement "grassbank", in which certain grasslands are set aside and protected but can be used during drought (or other circumstances) temporarily by ranchers who can move their cattle onto the grassbank until their lands recover. The rancher, as payment, places land of equal value into an easement held by the Malpai Borderlands Group to prevent land subdivision.

The Malpai Borderlands Group, with its large landscape operational focus, faces many of the governance challenges similar collaborative endeavors encounter. Participating landowners, federal agencies, and conservation organizations have different priorities and operate under different mission requirements. These differences make goal-setting challenging. But, in many ways, the goal-setting process, even in a context of competing values, is more straightforward than are the ongoing management and governance challenges. The organization requires ongoing funding both to implement projects and sustain decision making processes and relationships. The presence of multiple partners, including multiple federal partners, results in a need for continual negotiations and a need to resolve newly arising legal and operational issues. Despite these challenges, the Group has survived more than 15 years, improved land and water resources, and developed greater scientific understanding of the lands, water, and wildlife in the area.

3.4 Cienegas Watershed Partnership: An Intersection of Law and Voluntary Action

Several other collaborative efforts further illustrate the breadth and variety of collaborative efforts underway that reveal characteristics of shared, or network, governance. Moving beyond the informal and nonprofit governance models used in the Malpai Borderlands and, across the nation, in Maine at the Ducktrap River, the Sonoita Valley Planning Partnership in Arizona has evolved at the interface of

[6] Information comes from site visits by the author in 2003, 2007, and 2010. Other information can be accessed online at: www.malpaiborderlandsgroup.org

public and private lands in a context of conflicting visions and many land uses that include recreation, ranching, and preservation. Citizens joined with public land managers in a collaborative process to define land health outcomes and set a management regime to achieve those outcomes. The outcomes blend recreation, economic activity, and conservation.[7]

The U.S. Congress, at the request of early participants, created the Las Cienegas National Conservation Area within the planning area of the Sonoita Valley Planning Partnership. The Partnership developed a comprehensive landscape-scale planning process for the entire valley. The Partnership is a voluntary association of the Bureau of Land Management, Coronado National Forest, U.S. Geological Survey, Arizona Fish and Game, Arizona Land Department, Natural Resource Conservation Service, and Arizona Water Resources, conservation groups, biking and hiking clubs, grazing and mining interests, and local agencies and citizens. Ongoing exploration of ways to strengthen governance is underway. Currently a Cienegas Watershed Partnership, an umbrella organization, links other less formal groups such as the Sonoita Valley Planning Partnership and provides a fundraising arm to achieve the resource management goals of participating organizations.

These emerging partnerships use both voluntary collaboration and increasingly formal, cross-jurisdictional governance structures to shape incentives, influence accountability, and enhance coordination. These efforts display some common features. All draw upon local knowledge and location-specific information, integrating that experiential knowledge with the scientific and technical knowledge of experts.

Experiential knowledge, coupled with scientific knowledge, can help identify options for problem solving. An Alaskan example illustrates this point. Along the coasts of Alaska, the U.S. Fish and Wildlife Service had identified certain fishing practices as detrimental to albatross. Rather than seeking to prohibit fishing or prescribe fishing practices, the Service collaborated with the local fishing community that, once informed that their practices may have had adverse impacts on albatross, used their intimate knowledge of their boats and equipment to come up with alternative fishing practices. The result benefitted the environment while sustaining the livelihoods of people in the local community (Melvin et al. 2005).

4 Common Themes of Network Governance

Each of the examples on shared governance presented here also enhances incentives and inspires conservation by linking conservation to economic action, community well being, and citizen engagement. Use of incentives does not signify monetary

[7] Information results from a site visit by the author in 2009. Information can also be obtained at: http://www.blm.gov/wo/st/en/prog/more/partnerships_home/tools/case_studies/sonoita.html. Accessed 29 Aug 2010.

payoffs. Rather, the concept of incentives refers to those practices and policies that engage rather than confront citizens.

Consider the reflections of one farmer in Buffalo Creek, Pennsylvania. After he had put a stream bank fencing up, he called a Fish and Wildlife Service officer saying: “I saw a yellow warbler today!” The Fish and Wildlife Service agent asked: “how do you know, I thought you had no interest in wild birds?” The farmer replied: “Since re-establishing my stream bank, I now have a bird book.”[8]

Partnerships and models of shared, or network, governance, such as those described in this narrative, are also characterized by a decision-making context that generates technical and institutional innovation and iterative adjustments. The Sonoita Valley Planning Partnership uses an adaptive management framework to adjust land management practices based on information generated through ongoing monitoring. That information is evaluated against pre-determined management goals. Where actions are not achieving intended results, practices are adjusted. The iterative process also creates a context of innovation in which different practices are tested and evaluated for effectiveness.

Finally, the examples described above enhanced coordination while preserving local expressions of individual priorities and values. Along the Ducktrap River, farming, hunting, snowmobiling, restoration and conservation interests and advocates have collaborated to define shared goals. The goals themselves are holistic ones that take into account environmental, community, and economic goals. The Ducktrap River, Buffalo Creek, the Malpai and elsewhere present models of collaboration and shared governance that bring different interests together with a mosaic of objectives and a variety of values.

These models of collaborative conservation and network governance offer an optimistic decision framework. But such collaboration and networks are not easy. A caveat is also in order. In the novel *Ahab’s Wife*, by Sena Jeter Naslund, the heroine remarks that she wishes words were like music so we could play many strands at once. Many have reservations about cooperative conservation: “What if everyone doesn’t want to co-operate?” “What about those individuals who are ornery – who work against the common good?” These observations have merit, and cooperation won’t replace prescription. The governance challenge is not an “either-or” one of choosing between an environmentalism of regulatory compliance and an environmentalism of cooperation. Rather, the challenge is one of emphasis and orientation.

5 Challenges for Networks and Collaborative Conservation

As the discovery process of network governance unfolds, agencies and communities need new skills and different information. Better metrics are imperative as such collaborative models typically focus on achievement of measurable results. Resource

[8] Communication with the author, 2002.

managers, implementing requirements under major environmental statutes developed in the past half decade, have developed methods and practices for tracking permits and monitoring compliance, but they have devoted less time to developing metrics and protocols to measure and assess on-the-ground results. Agencies are often hard pressed to tell people exactly how to measure healthy forests or healthy grasslands. The Nation still lacks widespread, consistent data on water quality.

Collaboration and network governance also require skills in mediation, negotiation, and conversation. Author William Isaacs refers to dialogue as "conversation with a center, not sides" (Isaacs 1999) He suggests that dialogue requires listening, which, in turn, requires that participants in collaborative conversations "develop an inner silence" as others speak.

The interaction among scientists and participants in collaborative processes can be especially challenging. Scientists often perceive their appropriate role as researching and reporting information rather than as engaging in collaborative processes that define the research problem and may include scientists in selecting management options. A related challenge is that adaptive management, as currently practiced, sometimes unfolds within a traditional science-management framework in which the scientists develop the monitoring and research plans without full engagement of managers. Adaptive management plans thus sometimes fail to address key management challenges, or, when they do address such challenges, have no clear mechanism to translate new information and insights into revised management actions.

Finally, collaboration and shared governance require the development of additional and sometimes different governing rules and public-sector budgeting processes.

6 Collaborative Governance at a Landscape Scale: Governance Characteristics

At the 2009 National Ecosystem Restoration Conference, panelists at a special session on governance identified governance characteristics important in landscape-scale conservation and restoration settings involving multiple participants from many agencies and organizations, both public and private (Boesch et al. 2009). The panelists noted that: "Sustained action to achieve agreed upon results requires ways of coordinating action to set priorities, determine performance criteria, select and fund actions, oversee results, and make course corrections when necessary." They identified the following six characteristics as relevant in establishing the structures, organizations, decision processes, and institutions through which governance of landscape-scale projects can occur. These include:[9]

- **Rules and legal framework**: Participants need to operate within clear decision making processes and a framework for delineating roles and responsibilities.

[9] Unpublished document, distributed at the National Conference on Ecosystem Restoration, Los Angeles, CA 2009, available from Lynn Scarlett at lynnscarlett@comcast.com.

Rules can be both formal and informal but participants need agreed upon processes and rules that establish participation criteria and decision-making criteria and processes.

- **Decision-making authority and responsibility**: In a multi-participant context, governance rules need to include mechanisms for settling decision disputes, communicating decisions, and determining what actions shall be undertaken and by whom. Clear authority for reaching final decisions and clear lines of responsibility for undertaking actions support effective governance.
- **Mechanisms to generate and integrate relevant science and other information into decision making**: Good governance requires resources and procedures to find and/or create and evaluate information relevant to understanding landscape conditions, cause-effect relationships, trends, technical and other management options and their likely effects, and near-and long-term outcomes of management strategies. Relevant information includes both scientific information and experiential knowledge that comes from professional experience, familiarity with place, and practical knowledge of resource management traditions, tools, techniques and technologies.
- **Collaboration**: In cross-jurisdictional, cross-ownership, multi-value contexts, governance requires a mechanism to give expression to these multiple values and points of view. Decisions about land, water and wildlife management often involve an intersection of many, often competing goals and values. Giving expression to these many goals and values provides decision-making legitimacy and sustainability and can help resolve conflicts.
- **Accountability and resilience**: Governance requires the ability to define problems, evaluate options for addressing them, selecting management options, assessing whether hoped for outcomes are achieved, and adjusting actions if course corrections are needed. This process of oversight and adjustment requires clear assignment of accountability and means, such as adaptive management, to respond to new information and dynamic circumstances and revise actions, as necessary.
- **Ongoing coordination mechanism(s)**: With multiple participants over time operating at a landscape scale, mechanisms for coordinating action among participants and over time is essential to assure that decisions and actions among participants are consistent, compatible, and directed at defined outcomes.

Emergent resource management initiatives that are building models of shared governance, such as those unfolding at the Cienegas Watershed Partnership, Klamath Basin, and elsewhere, are experimenting with various ways to fulfill these governance requirements. However, federal, state, and local laws, regulations, organizational structures, and budgeting processes are not well-aligned to support these ventures in shared governance. Briefly, these challenges fall into five categories:

- **Structure**: Land and resource management responsibilities and environmental oversight are divided and distributed among multiple agencies – the oft-referenced "silo" context. Where responsibilities are shared among federal, state, and local agencies, the model is one of tiered or layered responsibilities rather than one of "collaborative federalism." (Emerson et al. 2011).

- **Focus**: Individual agencies generally have either a specific geographical focus or a set of specific topical responsibilities. Both types of disaggregation of responsibilities tend to steer decisions toward focusing on issue or geographic subsets rather than whole ecosystems or cross-boundary challenges.
- **Rule Design**: Many agency rules are described in prescriptive rather than performance terms, which makes use of tools like adaptive management challenging.
- **Budgets**: Most funding for landscape-scale conservation and restoration efforts remains situated within annual budgeting and appropriations, limiting potential for multi-year, integrated and sequenced project planning and implementation. Moreover, budgeting typically occurs on a bureau by bureau basis, missing opportunities for coordinating and integrating priorities through cross-cut budgeting, though there are occasional exceptions. Finally, available funding typically has a targeted focus, such as for habitat conservation planning or wetlands restoration, with few programs available to support general governance, planning, and monitoring of landscape-scale efforts or to support multiple project elements that transcend individual program purposes (McKinney et al. 2010).
- **Processes**: Particularly within the federal government, decision processes are not well designed to facilitate partnerships, cooperative agreements, and collaborative governance. The National Environmental Policy Act sets forth requirements for public comment on federal agency resource management decisions, but in their implementation of the Act, agencies have tended to foster use of passive and formal public commentary rather than collaborative and consensus-based decision contexts. Other laws, such as the Federal Advisory Committee Act have sometimes served to limit federal agency collaboration with stakeholders.

None of these features stands wholly in the way of landscape-scale initiatives in collaborative resource management and shared governance. The proliferation across the Nation of collaborative conservation attests to at least a degree of nimbleness available within the long-standing set of rules, processes, and budgets that guide resource management. How well these efforts succeed over time will depend, in part, on whether those rules, processes, and budgets offer sufficient "decision space" for ongoing experimentation in shared governance.

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Chapter 10
Managing the Science-Policy Interface in a Complex and Contentious World

Kathi K. Beratan and Herman A. Karl

Abstract Most of the significant problems planners, resource managers, and public sector decision makers have to deal with are emergent from dynamic interactions among component elements of complex adaptive systems. Such problems are known as 'wicked' problems because inherent uncertainty is high, so that it is not possible to precisely predict the outcomes of any action or event, and addressing the problems involve trade-offs between competing and often incompatible objectives and thus require balancing among differing value judgments. This complexity has profound implications for the role of science in policy making. Adaptive co-management has been suggested as an appropriate approach for addressing science-intensive 'wicked' problems, but has proven difficult to implement. Successful cultivation of an effective collaborative adaptive management process requires careful attention to process design to ensure that the necessary diversity of viewpoints and expertise - scientific, technical, and experiential - are fully included and that substantive and constructive dialogue is supported. Scientists seeking to more effectively integrate their science into such a process face the challenge of how to participate effectively without compromising the quality of their science. In this paper, we present concepts and recommendations that should be considered when designing an adaptive co-management process, and explore ideas for management of the science-policy interface.

Keywords Coupled human-natural systems • Engagement • Natural resource management • Adaptive co-management

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1 Introduction

1.1 The Challenge

Nations and communities face a number of inter-related crises of global scale which result from complex and poorly understood processes that operate at a wide range of spatial and temporal scales, involve natural systems that cross jurisdictional boundaries, bring into contention widely differing stakeholder values, and are managed by a highly fragmented regulatory patchwork. Scientists have increasingly recognized that disruptions to one element of the global social-ecological system can reverberate throughout the system in surprising and potentially catastrophic ways (Holling 2003). Increased understanding of this complexity has led many scientists and decision makers to view established mechanisms and institutional frameworks for natural resource management and environmental problem solving as inadequate. Governance structures have been cobbled together over time as new laws have been enacted and new agencies created. This unplanned structural evolution often results in fragmented responses and reaction to crises, rather than systematic evaluation of options that can lead to constructive and strategic choices (Daniels and Walker 2001; Briggs 2003). In some cases, this reactive framework supports a tendency to address the wrong problem or to obscure “a more profound problem by preoccupation with a lesser issue” (Catton 1989). Far from solving problems, management actions resulting from a crisis-driven (reactive) decision-making process commonly result in creation of a whole new set of problems, the unexpected and unintended consequences of poorly informed decisions (Stanford and Ward 1992; Holling and Meffe 1996; Kates and Clark 1996). Well-studied examples of this dynamic in the realm of natural resource management include fire suppression (e.g. Kilgore 1979; Christensen et al. 1989), flood control (e.g. Meffe 1984; Wohl 2000), and fisheries management (e.g. Clark 1985; Finlayson and McCay 1998; Hamilton et al. 2004).

Reflecting on the inadequacies of the crisis-reaction decision model, some analysts have pointed to c*ollaboration* geared for *adaptive management* as a promising alternative for addressing complex management problems (Buck et al. 2001; Koontz et al. 2004; Olsson et al. 2004; Carlsson and Berkes 2005; Anderies et al. 2006; Olsson et al. 2006; Walker et al. 2006) In this adaptive co-management model, scientists, stakeholders, and decision makers work together to deliberately learn from experience. Increasingly, managers in different agencies and jurisdictions are adopting recommendations such as supporting inter-agency cooperation, and collaborative and participatory planning and management (Clark et al. 1996). But such coordination and collaboration are difficult to achieve in real-world management situations (Miller 1999). Clearly, there is a significant gap between concept and practice.

The objective of this paper is to provide an introductory overview of promising strategies and tools, including collaborative decision making frameworks, for more effective decision-making and management related to scientifically complex, dynamic, and socially/politically-charged issues.

1.2 Our Vantage Point

We are physical scientists by training. One of us (Beratan) was a sedimentologist who studied the tectonic history of the Mojave Desert. The other (Karl) was a marine geologist who studied sediment transport processes on the ocean floor. This paper is about the making of policy and management decisions. How have two traditionally trained physical scientists ended up working on social science issues? Our own stories in many ways mirror the changes now occurring in the way scientists interface with society. Both of us were trained as researchers "to advance the store of human knowledge" through "curiosity-driven science." We were educated to believe that the deep, highly specialized knowledge we gained through our research would eventually benefit humanity. In the course of our research careers, we each began to feel a need to play a more direct role. We were naïve, however. Trained to the "ivory tower," we each thought that all we needed to do was to offer our valuable services to grateful decision makers, and "better" decisions would soon result. How little we knew about the real world! Both of us independently ran into brick walls. The gist of our first conversations was: "We scientists know so much – why won't anyone listen to us?"

To answer this question, we began to talk with as many different people as possible, including social scientists, economists, resource managers, mediators and citizens who were actively involved in their communities. At first, lack of common vocabularies hindered these conversations. As we began to understand what was being said, we began to recognize the enormous differences in basic assumptions and strategies among the diverse disciplines and practices. In the process, we became aware of our own assumptions and biases. We could tell that we were making progress by the amount that we realized that we didn't know – the world is a more complex and contentious place than we had thought.

Our focus has been on the practical question of how scientists can do a better job of integrating their science into the policy process. As emphasized by Folke (2002), "[d]irecting human behavior towards improved environmental performance and sustainability is not just a simple matter of providing information and policy prescriptions but a complex socio-cultural process." In other words, we now understand that the challenge facing us as scientists is to find ways to participate effectively in that process without compromising the quality of our science. This paper describes our response to that challenge, based on an integrative review of innovative work from many fields, filtered through our own experiences. Our target audience is researchers and practitioners involved in decision-making and management, the people on the ground who are trying to get things done. Therefore, we concentrate on practical applications and implications of current concepts.

2 Background: From Arrogance to Humility in Environmental Science

> Cocksuredness about complex issues is a telltale sign that it's time for a second opinion. But even that determination is a tough job for the citizen who is not very familiar with typical scientific debates.
>
> (Schneider 2000)

2.1 A Paradigm Shift

In recent decades, a profound shift has occurred in scientists' understanding of the relationship between humans and the "natural" world, and in our understanding of what we can accomplish with our scientific knowledge in the "real" world. Since the end of World War II, western science has been dominated by a mechanistic worldview that favored a reductionist approach to science. The reductionist approach is based on the assumption that each system of interest can be understood as the sum of its parts, so the best way to learn about a system is to study each part separately and in great detail – with enough effort, systems can be fully understood and therefore controlled (Knight and Meffe 1997) and managed to maximize outputs for human consumption (Cortner and Moote 1994).

A classic example of this mechanistic, reductionist view is the "command and control" approach to environmental resource management that has dominated practice for the last half century. Both researchers and managers have viewed the natural world as ordered, segmented, and mechanistic, with linear, cause-and-effect relationships. Underpinning assumptions are that the problems being addressed are well-bounded, clearly defined, relatively simple, and generally linear with respect to cause and effect. It follows that it should be possible to develop quantitative models that can accurately predict future conditions based on observations of events and processes collected over a limited time period (years to decades), and to base management decisions on these (Holling and Meffe 1996).

In their groundbreaking paper on "the pathology of natural-resource management," Holling and Meffe (1996) described how command-and-control management strategies have produced catastrophic outcomes such as highly destructive wildfires and floods and the collapse of marine fisheries, reflecting fundamental flaws in the underlying assumptions. They argue that command-and-control strategies applied to resource extraction from natural systems such as forests often focus on reduction of the range of natural variation of these systems – their structure, function, or both – in an attempt to increase predictability or stability so as to maximize extractive benefits.

Ecosystem research has demonstrated that, far from being simple and predictable, natural systems are complex and dynamic (e.g., Wu and Loucks 1995; Levin 1998). When natural levels of variation are reduced through command-and-control activities, the system is more susceptible to undesirable changes in composition and function in response to disturbance than is an unaltered system. Attempts to stabilize a natural system generally result in loss of a system's *resilience*, its capacity to experience disturbance and still maintain its ongoing functions and controls (Gunderson and Holling 2002). Resilience is an *emergent* property of a complex adaptive system, and so cannot be understood simply by separately studying the individual elements of that system. Effective management of resilience requires knowledge about the dynamic behavior of the system as a whole, including the linkages among the various system elements.

2.2 Moving Towards "Humble Science"

> Complexity has contributed to our understanding of biology, of large-scale computer networks, of social systems, of ecosystem function and of organizational management. It has taught us to expect surprises, to question the prevalence and even the desirability of stability, to think and look outside of a box, and to be more humble in our attempts to **control** things.
>
> (Ruitenbeek and Cartier 2001, p. 9)

> However, I believe that a communicative approach to analysis must be a humble approach. By that I mean that the analyst must be willing to listen, to explain, and to tolerate diverse views. The advance of knowledge depends on a successful dialogue and a willingness to explore worldviews that differ from one's own.
>
> (Andrews 2002, p. 41)

Across many fields in the social and environmental sciences, there is increasing recognition that most of the significant public issues facing local communities are the products of complex interactions within dynamic environments (e.g. Ostrom 1995; Eidelson 1997; Bramson and Bliss 2002; Folke et al. 2005; Calton and Payne 2003; Connick and Innes 2003; Lachapelle et al. 2003; Lasker and Weiss 2003; Allen et al. 2005; Wagenaar 2007; Ferreya et al. 2008; Webber and Khademian 2008). Persistent, ill-defined (also called "messy" or "wicked" (Rittel and Webber 1973; Allen and Gould 1986; Ackoff 1999)) societal problems such as domestic violence, homelessness, or degradation of valued ecosystems, are now understood as emerging from dynamic interactions among component elements of complex adaptive systems, influenced and constrained by broader-scale processes and conditions (Gunderson and Holling 2001; Olsson et al. 2006).

This complexity contributes to the challenges encountered at the interface between science and policy. This interface is challenging to manage not only due to the complexity of the natural systems we seek to manage, but also because policy decisions pertain to people, their preferences, and competing priorities, which are pursued within a context of constraints – financial resources are finite, timeframes within which to act are sometimes limited; and fulfillment of some priorities may preclude pursuit of others.

Various people and groups have different and equally valid perspectives about what system components and behaviors are important and valued, and those values and priorities evolve over time in response to additional information and changing conditions. In addition, the individuals or groups that are most impacted by a given situation often do not have the responsibility and/or power to change the situation. A key question, however, is whether science (and scientists) can help decision makers and stakeholders better identify resource management options, better understand the consequences of different policies and management choices, and, possibly, find "outside-the-box" options that can satisfy many priorities and value-sets simultaneously.

Command-and-control management strategies can be very effective in situations where there is agreement on goals, and where cause-effect relationships are well-understood. However, almost none of the currently significant environmental and societal problems meet these two basic criteria. Instead, goals are difficult to agree upon because decisions about what to do involve value judgments, questions of cost and feasibility, as well as scientific expertise. Problems are highly interlinked and complex, which limits our ability to decipher cause-effect relationships. In short, they are 'wicked' problems.

A key contributor to the 'wickedness' of such problems is that it is impossible for scientific and technical studies to fully and accurately predict the system-wide consequences of decisions about particular system elements, and so the probable results of alternative policy options cannot be determined with any great level of confidence. Science can provide guidance regarding the probable consequences of a given management action, or at least identify what parts of a system might be impacted, but never with 100% certainty. In short, uncertainty is inherent, and surprise is inevitable.

Standard decision making processes tend to be disrupted by uncertainty and surprise. When participants expect stability and predictability, uncertainty can open the door for competing interests to use science as a weapon rather than as a guide. Competing interest groups can produce conflicting information and predictions prepared by warring experts as part of an adversarial and contentious process (Ozawa and Susskind 1985; Adler et al. 2000). Thus, a focus on scientific disagreements often serves as a cover for differences in values and priorities among stakeholders. Even when decision makers are honestly trying to address resource management problems, they frequently find themselves faced with seemingly contradictory information, and thus tend to place especially heavy weight on scientific advice that happens to support a decision they prefer on other grounds (Ozawa and Susskind 1985). In these instances, the full suite of relevant scientific expertise does not contribute to public decision-making (Andrews 2002).

2.3 Rethinking the Science-Policy Conversation

Human communities, as summarized earlier, are dynamic, diverse, and complex, with people having many values and differing priorities. At the same time, natural systems are also dynamic, diverse, and complex. The bottom line for practitioners is that addressing wicked problems – problems involving complex, non-linear systems – requires at least as much attention to human interactions as to scientific knowledge. Decision making is certainly complicated by incomplete systems-level understanding of how a natural system (e.g., a watershed) functions, and how the natural and social systems interact. However, the search for solutions requires much more than a model-based search for an "optimal solution" to a particular problem. An ongoing learning and negotiation process is needed that focuses on questions of communication, perspective sharing and development of adaptive group strategies for problem solving (Huxham 2000; Pahl-Wostl 2002a, b). Emphasis "must be placed on learning and consensus building – learning because understanding cause-effect relationships is fundamental to choosing an effective alternative (and learning from the consequences of selecting that alternative), and consensus building because agreement on goals is required before socially acceptable action can take place" (McCool and Guthrie 2001, p. 310).

3 The Science-Policy Interface

3.1 The Role of Science in Policy Development

> Most technical work collects dust instead of kudos. Much analysis never properly enters the process of making decisions. It may appear too early or too late, contain inappropriate information, or lack legitimacy. Onto the shelf it goes! Competing analyses may cancel one another out so that both end up on the shelf, a valid but annoying result. Other work fails to enter the long informal process of fact-finding and negotiation that precedes a formal decision, and therefore it may be ignored.
>
> (Andrews 2002, p. 109)

Decisions must be made despite uncertainty. Much uncertainty is inherent and effectively irreducible. Even in cases where uncertainty could be reduced through further scientific research, decision makers generally do not have the luxury of time to wait for scientists to conduct "definitive" studies. However, this does not mean that science has nothing to offer decision makers; there is valuable scientific knowledge available that can usefully inform decision processes. In order for this information to be used appropriately and effectively, scientists need to find more effective ways of explaining what is currently known, what can be known, and what is, in effect, 'unknowable.'

Technical experts employed by the decision-making organization or by hired private consultants normally supply needed technical information to decision makers. There are at least three common problems with this process. First, the information will not be useful if the decision makers did not have sufficient understanding to ask the right questions in the first place. Question framing is one of the most difficult and least considered parts of the decision process. Second, the information will not be viewed as unbiased and reliable if there is a lack of trust among citizens and organizations. Third, the information will not be used if it is presented in language that is difficult for non-experts to understand. An additional complication is that, in many cases, choosing an expert often requires an expert, and the decision makers may not select the most appropriate expert for the question at hand (Robison 1994). Decision makers do not need to be expert themselves – it is, of course, impossible for one person to be an expert on everything – but they need to have some way of identifying appropriate experts that can assist in framing questions and in assessing and integrating the input from other experts.

Another difficulty is posed by the mutual lack of understanding between scientific experts and decision makers. Scientists and decision makers come from dissimilar professional cultures with different purposes, values, norms, and reward systems. As a result, the two groups tend to approach problems and issues very differently, with little incentive on either side to change and broaden their horizons. For example, scientific researchers rarely consult with decision makers when selecting and developing research projects; consequently, despite the scientific merit of a study, the results may not be relevant to the decision makers. The mismatch of research focus to practical need tends to be compounded by communicative disconnects. "Quite often scientific researchers produce complex results, they do not communicate those results simply and concisely – they do not seem to be able to convey the essence of what their research is saying in language the policy maker can understand" (Wiltshire 2001). Cash et al. (2003) point out that scientific information is only likely to influence public perceptions and policy development to the extent that the information is perceived to be not only credible, but also salient and legitimate. The common failure of technical experts to address one or more of these three criteria results in production of information and recommendations that gather dust on shelves and that are not followed up on – frustrating to experts, decision makers and citizens alike.

Effective provision of science in support of decision-making requires a different approach and a different type of scientific expert. Fischer (1999) terms such people "participatory experts," and describes their task as facilitating citizen learning and empowerment, assisting citizens "in their efforts to examine their *own* interests and to make their *own* decisions" rather than "providing technical answers designed to resolve or close off political discussion." Fischer (1999) describes the job of the participatory expert as assisting the lay participants with the scientific findings, explaining how they were derived, what they mean, the degree of certainty that can be attached to them, and most importantly, what kinds of normative assumptions they rest on. In addition, the participatory expert assists the participants in their efforts to collect relevant empirical information about their own particular social settings. A critical focus of this facilitation role must be to build a broad understanding of complexity and uncertainty, a difficult communicative challenge.

3.2 The "Balancing Act"

Managing complex social-ecological systems is a delicate balancing act, requiring flexibility, sensitivity, and courage. Public sector managers have to make decisions in a context of multiple objectives, seemingly contradictory requirements (Table 10.1), and fluid conditions. Any decision will, or will at least appear to, favor one set of values over others. Such value judgments are very risky for decision makers, with potential conflict between long-term outcomes and short-term career impacts. There is seldom a simple and objective 'bottom line', like profits, against which

Table 10.1 Examples of dynamic tensions that must be balanced in decision making

Institutional stability is needed to ensure that projects are conducted efficiently and effectively, and reach completion. And Institutional flexibility is needed to permit changes in response to new information, and adaptation to changing conditions
Decisions should be based on the best possible science And Decisions should be responsive to citizen's values and concerns
Clearly defined goals and careful long-term planning are needed for sustained and effective cooperative actions And Managers will need to be creative in adapting actions to new information or new conditions
Trust and commitment are required from participants in order to establish effective co-management And Not everyone, or every organization, is trustworthy; trust must be earned
Identifying win-win solutions requires optimism – belief in the possibility that problems can be resolved And Identifying and implementing feasible actions requires political savvy, along with a healthy skepticism about suggested scenarios and potential impacts of response options

actions and outcomes can be judged. Thus, evaluations can be strongly influenced by political responses based on short-term impacts.

A particularly frustrating conundrum facing managers is the difficulty of gaining support for actions intended to prevent a crisis. Managers know that preventing a problem generally is more effective and cheaper than trying to fix a problem. Action usually has immediate and obvious costs, ranging from loud outcries from affected economic interest groups to the risk of embarrassment if the policy or management action does not perform as expected. In contrast, the costs of inaction are seldom so immediate: some interest groups may complain, but these complaints can often be overcome by pointing out that delay allows more time for research and careful planning. For many decision makers, even a short delay can be enough to ensure that someone else will have to make the decision (Walters 1997). Not making a decision is, of course, a decision to maintain the status quo; this option is often the safest one for a decision maker, even if it results in poor outcomes.

Balancing the trade-offs between flexibility and stability is an example of the institutional challenges facing management organizations. Brown and Eisenhardt (1998) argue that organizations can continue to exist only if they maintain a balance between flexibility and stability. They contend that an organization maintains strategic equilibrium over time through a combination of frequent small changes made in an improvisational way that occasionally cumulate into radical, strategic innovations, changing the terms of competition fundamentally. This can also be true for resource management situations, particularly those involving multiple organizations. Although flexibility is an important characteristic for dealing with surprise, there are times when a higher degree of flexibility increases the probability of making costly mistakes. For example, a natural resource organization may perform the role of maintaining the status quo, thus mitigating the temptation to overexploit a resource (Folke et al. 1998). In such situations, an organization's lack of flexibility may prevent poor (and possibly irreversible) choices.

4 Adaptive Co-management

A greater understanding of the dynamic tensions underpinning the management of complex natural systems has led researchers and practitioners to explore new approaches to decision making and design of management interventions. In order to shift the behavior of a system towards more positive outcomes, separate but coordinated management decisions and actions must occur at organizational levels that correspond to the time and space scales of the processes that play a significant causal role in shaping the system's behavior. Institutions that can cope with complexity also need to be organized at multiple scales and linked together effectively. As pointed out by Comfort and others (2001), increases in organized complexity require significant increases in information flow, communication, and coordination in order to integrate multiple levels of operation and diverse requirements into a coherent program of action that is flexible to respond to surprises. Therefore, adaptive co-management concepts have been a focus of management innovation.

Adaptive management can be broadly defined as a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs – "learning by doing." This management strategy has emerged in response to recognition that uncertainty is a fundamental characteristic of complex environmental systems (CAMNet). Adaptive management efforts commonly begin by integration of existing interdisciplinary experience and scientific information into dynamic models that are used to make predictions about the impacts of alternative policy or management choices. This step results in problem clarification and enhanced communication among scientists, managers, and other stakeholders. It also provides a policy screening mechanism that can be used to eliminate ineffective options and to help managers identify key knowledge gaps. Ideally, these gaps are then filled through focused, large-scale management experiments (Walters 1997). Management activities are then modified as indicated by information gained from subsequent monitoring and evaluation. The overall goal of adaptive management is not to maintain an optimal state of the resource. Instead, the goal is to develop greater management capacity (Johnson 1999) through increased knowledge of the particular system's dynamic behavior and by establishing the good working relationships among key actors that is necessary for generating sufficient institutional flexibility to allow managers to react when conditions change (Gunderson 1999).

Although adaptive management shows great promise for natural resource management, implementation has proven difficult. Only rarely have the results of deliberate experimentation or systematic monitoring of outcomes been translated into revision of policy and plans. A major contributor to the implementation gap is lack of attention to the dynamics of the human element, the social side of decision-making. As pointed out by Lee (2001), adaptive management is experimentation that affects social arrangements and how people live their lives. The conflict encountered in undertaking such experimentation is a central reason that adaptive management has had more influence in concept than in practice. The most notable successes have occurred where the management structure was simple, with most of the authority and responsibility residing within a single organization. For example, forest managers have used the results of experiments comparing the outcomes of competing management strategies at the stand level to guide management decisions (e.g., Sit and Nyberg 2000).

The barriers to implementation are primarily social and political rather than scientific, and include: difficulties in developing acceptable predictive models, conflicts regarding ecological values and management goals, inadequate attention to nonscientific information, and an unwillingness by agencies to implement long-term policies seen as too risky or costly. Institutional factors include lack of institutional flexibility, inadequate strategies for stakeholder participation, and bureaucratic control of goal-setting and experimental design. Accordingly, recent work has focused on methods for integrating social, political and institutional factors with scientific practices. One goal of this work is to encourage resource users and agencies to see adaptive management as a tool with potential long-term benefits for all involved, not just as a method to promote the self-interest of agencies or specific user groups (Johnson 1999). In a particularly promising development, adaptive management efforts are increasingly adopting approaches derived from the field of mediation and dispute resolution, such as consensus-building (e.g., Susskind and Field 1996; Susskind et al. 1999), joint-fact-finding (e.g., Andrews 2002), and participatory decision-making (e.g., Innes and Booher 1999; Beirle and Cayford 2002).

Collaboration among management organizations in an adaptive management setting is supposed to increase the likelihood of effective implementation, leading to more positive outcomes. In addition to reducing conflict, collaboration is assumed to produce synergistic results, where the outcomes of the collaboration as a whole are greater than the sum of what individual partners contribute (Brinkerhoff 2002). Natural and social processes occur at a range of spatial and temporal scales, with complex and significant cross-scale interactions. Thus, management institutions must also operate at and integrate across the same range of scales. Folke and others (1998) point out that local institutions play an important role in monitoring and responding to ecosystem change, but in order to be effective, they must be connected to larger institutions in a way that permits flexibility, adaptability, and resilience.

Collaboration and partnerships are touted as answers to many public service challenges. However, collaboration is not a panacea; when used poorly or in inappropriate situations, it can create more problems than it solves (Imperial and Hennessey 2000). A failed process comes at a heavy cost of time and effort and, perhaps more significantly, in social capital consumed rather than built (Conley and Moote 2003). Compromise and bargaining to the 'lowest common denominator' such that no participant's interests are threatened will increase the probability of policy acceptance and implementation but may also result in a sub-optimal policy that fails to effectively address the problem. In addition, since collaboration is limited to issues of mutual interest, controversial issues will tend to be avoided, perhaps leading to avoidance of the most important problems (Imperial and Hennessey 2000).

It may be difficult to persuade key organizations or stakeholders to participate in a collaborative process, since it requires ceding some control, sharing risks, and becoming dependent upon others for success (Himmelman 1996). Investment in a collaborative process and the development of stable network relationships may make it difficult to adapt and change in response to future events (Milward and Provan 2000). This stasis can be a critical limitation in a particularly dynamic situation. Prerequisites to effective partnership relationships include the tolerance of partners for sharing power and a willingness to adapt their operations and procedures to facilitate the partnership's performance (Brinkerhoff 2002). The presence of partnership champions, entrepreneurial individuals who advocate on behalf of the partnership and the partnership approach within each partner organization, is another facilitative factor.

The up-front costs of adaptive co-management are high in time, money, and political capital, but the probability of reaching an acceptable outcome may be greatly increased over adversarial or fragmented approaches. In addition to achieving better outcomes, collaborative adaptive management may well result in significantly lower long-term costs through avoidance of lawsuits and preventable crises. Even if considered desirable and cost-effective, however, organizations cannot participate in a collaborative adaptive management process unless they have sufficient resources. If no organization can do more than send staff to a meeting, it is unlikely that the group of organizations can accomplish much (Imperial and Hennessey 2000). In addition, long-term management efforts require continuity in vision, goals and implementation in order to prevent the program from disappearing or disintegrating into loosely related projects. This continuity requires an organizational structure that is somewhat insulated from changes in leadership, and careful articulation of a long-term research and assessment strategy (Patrinos 2000).

4.1 Public Participation

Citizen (stakeholder) involvement at all stages of decision making is a fundamental element of adaptive management. Unlike many other political issues, some environmental risks must actively be brought to the citizen's awareness to be identified as a social threat (Fischer 2000). Thus, citizens must be linked to science early in the decision process. Because changes in public policy often are driven by citizen demands, absence of public involvement in the early stages of decision making will result in an ineffective problem-solving process that is reactive rather than proactive, favoring crisis management rather than problem avoidance. Therefore, collaborative approaches that include citizen involvement have become a common component in resource management efforts, with the goals of increasing knowledge, building consensus, improving agency decisions, generating acceptance of agency actions, increasing trust, and empowering citizens. For example, the U.S. Congress has mandated a role for public participation in governmental decisions through the National Environmental Policy Act (1969). the National Forest Management Act (1976), and many other statutes pertaining to resource and public land management. These statutes generally require agencies to allow the public to comment on national resource decisions.

Despite the popularity and common-sense appeal of the public participation concept, however, the actual level of public involvement achieved has been modest (Miller 1999), both in terms of overall numbers of participants and extent of decision making input. For example, some public decisions, such as the decision by the Interior Department to list the polar bear as threatened under the Endangered Species Act, generated hundreds of thousands of public comments within the NEPA process. However, these comments were constrained, under NEPA processes, to reacting (largely in writing) to agency documents. These limitations of NEPA processes for public commentary have, in part, fueled the press for more robust participatory processes that involve affected citizens in framing problems, identifying options for addressing them, and, in the most participatory contexts, actually engaging in final decisions.

Along a continuum from commentary to full engagement in decision-making, public participatory models are subject to various criticisms. Criticisms of the concept of public participation include: the substantial investment of time and resources required; the likelihood that poorly conducted public participation efforts will heighten, not alleviate, conflict; the difficulty in identifying and facilitating the inclusion of a truly representative group of stakeholders, potentially resulting in increased influence of special interest groups; and the concern among technical experts that the scientific or technical and factual basis of a problem or solution may be distorted, trivialized, or ignored (Charnley 2000).

Public participation in environmental issues is often an afterthought or the result of a crisis (Chess 2000), in part because many decision-makers believe that citizen involvement accomplishes little more than complicating an already difficult task that is best left to professionals. Thus, public involvement has often meant impersonal, linear forms of communication, such as newsletters or meetings at which administrators provide a one-way flow of information in an attempt to educate the public. Such strategies are relatively simple to implement, but generally are not effective at increasing public support for management actions or for identifying actions that can produce better outcomes (Shindler and Aldred Cheek 1999).

Despite these drawbacks, managers and decision makers are often required by law to make some use of public participatory tools, particularly under the requirements of NEPA. But, beyond basic legal requirements, some public managers use additional public participation processes for several purposes: to test the political efficacy of proposed alternatives, improve the knowledge base for decision-making, develop new ideas, co-opt alienated parties into the mainstream, share or delegate responsibilities, or build support for a proposed policy (Andrews 2002). Some of these efforts are, in effect, public relations exercises aimed at defusing public resentment rather than genuine efforts to develop adaptive problem-solving processes (Miller 1999). Indeed, the dominant public involvement process used by government agencies has been characterized as "inform, invite, and ignore" (Daniels and Walker 2001, 9), although this characterization understates the earnest efforts by many public decision makers to take into account various public perspectives and comments. Nonetheless, public-participation processes that result in few or no changes to agency decisions (or are perceived to have no impact on decisions) can weaken the relationship between citizens and their government (Moore 2000), reducing the likelihood of finding consensus-based and sustainable solutions to environmental problems.

Public participation is particularly important, yet commonly lacking, in the early stages of the decision making process. Based on a comparative evaluation of large-scale ecosystem restoration projects in the U.S., Van Cleve and others (2004, p. 11) concluded that the public has to be involved in defining the problem, since public buy-in at the problem-definition stage of the project is "tied to many aspects of the potential for progress towards meeting restoration goals." Diversity of viewpoints contributes to effective agenda setting and question framing by broadening the range of critical information about system conditions and dynamics that is available to decision makers.

Participant diversity can also spark policy innovation by helping decision makers view situations from different perspectives. The human brain has highly developed information-filtering and pattern-matching functions that are invaluable in making sense of complex and uncertain systems (Beratan 2007). However, these unconscious cognitive processes can ignore potentially relevant problem information (Payne et al. 1998) because they make use of past experience and resultant mental models to sort through the flood of incoming information and rapidly identify the most relevant bits. In other words, people tend to see what they expect to see, and miss evidence of change and surprise. This filtering results in a narrowing of viewpoint that can be very useful in stable situations, but is potentially dangerous in a dynamic situation. The danger of missing important clues about future system behavior can be reduced through broad participation in information-gathering and analysis processes, and sharing of information among participants. Each individual's cognitive filter is based on his or her unique set of experiences and assumptions, and so each person has a unique view of any given situation. An organization's response to that situation will reflect the views of key individuals within that organization. Organizations have distinct missions and cultures, and therefore each tends to attract and shape a cadre of relatively like-minded individuals; in turn, the shared cognitive filters of those within the organization shape the organization's views and actions. Inclusion of this individual and organizational diversity in the decision-making process can enhance the collective ability to recognize unexpected patterns and can encourage creativity and innovation. As Folke and colleagues (2003) point out, diversity provides the mix of knowledge and viewpoints necessary for creativity and innovation in response to surprise.

Despite the potential value of broad participation in decision-making, a participatory process that is poorly planned and implemented can worsen a problematic situation by reducing trust and damaging working relationships. A factor that requires particularly careful consideration is who should participate in the management process and in what capacity. Participation is essentially about building partnerships and implies that all the partners take their share of responsibility (Buchy et al. 1999). The question of which 'stakeholders' may participate is often very controversial as it is difficult to limit the number of groups that seek to be involved as a direct or minor stakeholder (Colfer 1995). Some process managers seek out only "professional stakeholders," politically active persons with a major stake in the policy decision, such as industry lobbyists and environmental advocates. Others define stakeholders more broadly and include any party potentially affected by the policy decision (Andrews 2002). A smaller number of participants allows for more efficient group interactions, but the absence of an influential group or an actor with relevant responsibilities can derail a decision process or limit the potential for positive outcomes. Whatever selection criteria are established, the process of selection has to be open and transparent, so that people are at least aware of the process used (Buchy et al. 1999).

Another challenge to broad participation is that it requires a lot of time and effort to plan and implement. It is particularly difficult to arrange for meaningful participation by citizens. Collective citizen participation doesn't just happen; it has to be organized, facilitated, and even nurtured (Fischer 1999). Many effective public processes can be traced to the presence of one or two agency individuals who galvanize the participatory process. However, this kind of outreach has been infrequent among natural resource agencies (Shindler and Aldred Cheek 1999), though there are signs that comfort with collaboration and efforts to engage citizenry may be increasing (White House 2005).

Many public-sector managers have traditionally been unprepared to deal with value-laden questions (Magill 1991), though these are precisely the kinds of questions that higher-level policy makers often address. Similarly, many public-sector managers have little experience facilitating civic discourse about difficult choices (Goergen et al. 1995). There is a clear need for agencies to identify and nurture staff that demonstrate both social skills and willing attitudes (Shindler and Aldred Cheek 1999).

5 Moving Towards Adaptive Co-management

Traditional organizational structures are not designed to encourage inter-organizational communication and coordination. The reward structure favors individual achievement over short time spans rather than collaboration on long-term issues. Specialized jargons make it difficult for people from different backgrounds and with different expertise and responsibilities to communicate with each other, in turn making it difficult to develop a holistic understanding of the dynamic behavior of a whole system of interest. Uncertainty is viewed as something to be gotten rid of rather than something that must be lived with. A long-standing and pervasive atmosphere of competitive and adversarial relationships will lead to lack of trust and protective behavior in both individuals and organizations. These barriers are part of the institutional context of decision-making. *Institutions* are loosely defined as the formal constraints (rules, laws, constitutions), informal constraints (norms of behavior, conventions and self-imposed codes of conduct), and their enforcement characteristics (North 1990; Lowndes and Wilson 2001).

As Healey (1997) points out, the process of collaborative strategy making is essentially a collective effort in institutional design in which the participants build new systems of meaning, new cultures, new organizing routines and styles, and new social networks. Such institutional adjustments are necessary precursors to major shifts in policy and management strategies and frameworks. Thus, institutions are a key link between social systems and ecosystems (Davidson-Hunt and Berkes 2003). Overcoming institutional barriers to collaboration and adaptive management is extremely challenging, but is critical to building the inter-organizational capacity needed to form effective partnerships.

Two complementary strategies for integrating science into decision making show promise for nurturing institutional evolution towards adaptive and collaborative management processes: process facilitation by *boundary organizations*, and reduction of adversarial tensions through *joint fact finding*.

5.1 Boundary Organizations

In every successful organization, there are people who are catalysts, who have a 'knack' for making things happen. They are adept at getting the "right" people talking to each other, they see connections between things that other people miss, and they ask the types of questions that spark creative and innovative thinking among colleagues. These key individuals are referred to as 'boundary spanners' since they are effective at building bridges across institutional and disciplinary boundaries. Boundary spanners can foster co-operation and exchange, act as neutral arbitrators in conflict resolution, and reduce communication costs and uncertainty (Williams 2002). The involvement of effective boundary spanners who are personally interested in maintaining ongoing relations between scientists and policymakers and among agencies has been cited as an important factor in developing effective inter-organizational relations (Clark et al. 1996). Central to the boundary-spanning role is the ability to earn the trust of numerous actors who must collaborate to promote effective change.

The role of boundary spanner is being increasingly formalized and institutionalized in multi-organizational partnerships. For example, as a step towards institutionalizing a partnership, the Criminal Justice/Mental Health Consensus Project recommends employing an individual as a boundary spanner and charging that individual "with maintaining the vision of the collaborative effort and managing on a day-to-day basis communication among staff working for each of the various collaborating organizations." (http://consensusproject.org/topics/toc/ch-V/ps26-institutionalizing-partnership)

Boundary spanning activities can also be carried out by a group of people (for example, one department in a larger organization) or by an organization (in a multi-organizational context). Drawing on the common concept of boundaries in social studies of science, David Guston in 1999 coined the term "boundary organization" to describe institutions that straddle yet join the relatively distinct domains of politics and science. Boundary organizations temporarily bring together and build bridges between opposing, primary authority figures or "principals" in these domains (Guston 1999, 2000). The U.S. Department of Agriculture's Cooperative Extension Service is an example of a boundary organization (Cash 2000). Extension agents act as a bridge between individual farmers and research scientists, providing a two-way link between research and day-to-day management activities.

The literature on boundary organizations suggests that they can provide an array of important functions. Among other things, they can: (1) "translate" scientific information from scientists to policy makers; (2) communicate research needs from policy makers to scientists; (3) protect scientists on one side of the boundary from accusations of bias or illegitimacy, while protecting policy makers on the other side from accusations of technocratic intrusions; (4) provide neutral forums for debate; and (5) create a site for building long-term trust between the policy and scientific community (Clark 1999). To effectively conduct boundary spanning activities, Guston (2000) suggests that an organization must be perceived by all participants as expert, and thus credible; apolitical and unbiased, and thus trustworthy; stable and long-lived; and flexible and responsive, and thus able to adapt to changing circumstances. Additionally, he states that a boundary organization must operate in a transparent fashion, insulating itself from external political authority by making itself accountable and responsive to opposing, external authorities.

Shepherding of a science-intensive collaborative management project by a boundary organization can be particularly important when there is a large disparity in resources and technical ability among the partners. Such disparities are very common in multinational efforts to deal with the environmental impacts of globalization. Meaningful participation can only occur if all participants have access to policy-relevant information. "Access" does not simply mean physical availability; the information must also be in a form that is readily understandable to all participants. A boundary organization can assist disadvantaged partners to get the training and information they need to fully participate.

5.2 Joint Fact Finding

Planning and implementing broadly acceptable actions in response to complex problems requires that the interested parties share an understanding of the technical dimensions of the problems they face. The mechanisms available for resolving science-intensive disputes – courts of law, administrative tribunals, legislative hearings, and the court of public opinion – are not designed to generate agreements that balance both political interests and scientific or technical concerns. This dilemma has led to the emergence of what are called collaborative approaches to resolving environmental disputes (Susskind et al. 2000). More specifically, it has led to experiments with a procedure called *joint fact finding*. Joint fact finding is a process by which representatives of key stake-holding groups in a science-intensive public policy controversy engage in a scientifically-informed dialogue aimed at building shared models of the systems involved and testing alternative policies or strategies for responding to their concerns (Susskind et al. 1999). Joint fact-finding helps participants deal with the technical complexity of the issues and scientific uncertainty, where this complexity and uncertainty create obstacles to agreement. Change requires creative thinking and careful experimentation, which are discouraged by adversarial processes. Many scientists are concerned that joint fact-finding will result in "science by committee" and produce the lowest common denominator science. Yet a properly designed joint fact-finding process can result in better science because it ensures that the best practices of scientific inquiry will be maintained and access will be provided for all participants to all forms of knowledge. As a component of a consensus-building, collaborative problem solving process, it can foster creative solutions that can lead to durable policy.

In joint fact-finding, the involved parties discuss what factual questions they believe to be relevant to the decision, exchange information, identify where they agree and where they disagree, and negotiate an approach to seeking additional information, either to fill gaps or to resolve areas of disagreement. A joint fact-finding process has several elements. First, rather than withholding information for strategic advantage, the interested parties are able to pool relevant information. Second, joint fact-finding involves face-to-face dialogue among technical experts, decision-makers, and other key stakeholders. Usually, a nonpartisan facilitator or mediator assists in orchestrating this dialogue. Third, this process places considerable emphasis on "translating" technical information – text, graphics, videos, web-based information and oral presentations – into a form that is accessible to all participants in the dialogue. Fourth, it incorporates local (lay) knowledge, as appropriate. Another significant aspect of the process is that while joint fact-finding is geared to building consensus, it tries to clearly "map" areas of scientific agreement and to narrow areas of disagreement and uncertainty.

A joint fact-finding approach is recommended for question framing as it provides a mechanism for reaching a broad consensus on the specific issues being addressed, and can contribute to building trust among participants. Question framing, asking the "right" question so as to solve the "right" problem, is among the most important determinants of the potential for success in any collaborative management process, but it is commonly underemphasized. Agreement among the key actors and stakeholders on the question of concern is an essential starting point for collaboration. The common lack of attention to and lack of transparency of the question-framing process can create an opportunity for special interests to pursue ideological agendas (Miller 1999), and is highly likely to seriously interfere with relationship building. For example, although collaborative adaptive management is a major focus of the Greater Everglades Restoration Plan (CERP), the organizational structure was fixed and the range of restoration options were pre-determined before science investigations were initiated. Key stakeholder groups were not involved in selection of the program's overall approach, critical research questions and research design; this lack of input has contributed to the major disagreements and legal actions that have plagued the program.

Joint fact-finding can also be an effective approach for model development. Dynamic models that integrate interdisciplinary experience and scientific information and that attempt to make predictions about the impacts of alternative policies are another important element of collaborative adaptive management (Holling 1978; Walters 1986; Van Winkle et al. 1997; Costanza and Ruth 1998). This modeling step is intended to serve three functions: (1) problem clarification and enhanced communication among scientists, managers, and other stakeholders; (2) policy screening to eliminate options that are most likely incapable of doing much good, because of inadequate scale or type of impact; and (3) identification of key knowledge gaps that make model predictions suspect (Walters 1997). The diversity of knowledge and viewpoint included in a joint fact-finding approach to model development can enhance both the scientific quality of the model and societal acceptance of the model results.

5.3 Joint Fact-Finding and Model Development

Models and scenarios can provide a view of possible futures, our 'best guess' answers to 'if—then' questions about the potential consequences of management actions. Precise predictions of future outcomes are almost never possible when dealing with complex systems. Instead, appropriate models can help define an "envelope of possibilities," a range of possible outcomes, for selected policies and future conditions. The models can also provide insight into the sensitivity of the system to particular actions and changes, thus allowing managers to make the most effective use of scarce funds and staff time.

Modeling and scenario development should be a continuing and dynamic process, responding to increasing understanding of system dynamics, as well as changes in larger- scale context (regional, national and global events). The cause-effect relations embodied in the models should be tested whenever opportunities present themselves, and the models adjusted accordingly.

Joint fact-finding is an appropriate tool for conducting 'alternative futures' exercises. A collaborative and transparent process such as joint fact-finding is needed in order for the modeling results to be widely accepted. All models incorporate some value-bound assumptions (e.g., the specifications of sub-system boundaries, the level of sub-system complexity, the extent to which historical data can be used to describe future circumstances, and the relative importance of forces and factors external to the model) (Ozawa and Susskind 1985) that are based on both the experience and biases of the people that develop the model. In addition, model development may be limited by the tendency of modelers to focus on the most readily available instead of the most important information, on measurable (quantifiable) variables, and on greater precision rather than increased accuracy and policy relevance (Miller 1999). The model development process should serve as a means of defining the system of interest, and of integrating what is known in order to identify the areas of uncertainty about the system's dynamics (Walker et al. 2002). Diversity of experience, background, and viewpoint can make for a more complete, accurate, and relevant model.

6 The Collaborative Adaptive Management Process

6.1 Designing a Collaborative Adaptive Management Process

Successful cultivation of an effective collaborative adaptive management effort requires careful attention to process design. A poorly designed project will almost always fail (Andrews 2002); simply agreeing that cooperation is a good idea is insufficient. Instead, a carefully thought-out and agreed-upon procedural framework is a necessary prerequisite for substantive and constructive discussion and negotiation. All parties must be supportive of the process and willing to invest the time necessary to make it work. Process design must take into account the unique dynamic of a particular situation's issues, history, technical information, players, relationships, and regulatory, legal, and community contexts.

The process description presented in the remainder of this paper is not intended to be a complete or detailed blueprint for action. Instead, we seek to highlight concepts, strategies, and activities that distinguish collaborative adaptive management from other management processes (e.g., environmental impact assessment, environmental management system, and risk management). We are particularly concerned with those process elements that relate to managing the science-policy interface in decision situations marked by complexity and uncertainty.

6.2 Considerations in Process Design

Several basic objectives should be considered in designing and managing a collaborative adaptive management process. The project leadership should consciously aim to:

- *Focus on developing trusting relationships among participants*. The first and most important requirement is trust; no real progress can be made unless and until participants develop at least some level of trust and respect for each other. Therefore, sufficient time must be set-aside at the beginning of the process for relationship building among partners. People need to know each other as individuals, not just as scientists, community members, or representatives of organizations. If people do not know each other, they will not trust each other and will revert to fear-based interactions (Adler and Birkhoff 2002). The necessary changes in attitudes and protocols will not occur overnight. Relationship building will be incremental and will require persistent and tender nurturing. For example, during the first 2 years of an ongoing effort to facilitate evolution of a collaborative multi-municipal watershed management process in southwestern Pennsylvania, staff from Duquesne University's Center for Environmental Research and Education (CERE) concentrated on developing trust-based relationships with several of the socially and economically diverse municipalities. CERE has built upon these relationships by conducting watershed management-related events at which representatives from the municipalities had an opportunity to work with each other and thus begin to establish inter-municipal connections (S. Kabala, 2004, personal communication). The investment made by CERE in relationship building has played a significant role in developing support for collaboration in this highly fragmented jurisdictional setting. In interviews conducted in 2004, several key decision makers in the watershed reported a noticeable change in attitudes among the participants (J. Myung, 2004, personal communication).

- *Put collaborative mechanisms into place before question framing occurs*. Because of the importance of question framing and relationship building, the earliest stages of an adaptive co-management project are arguably the most critical to the ultimate effectiveness of an adaptive co-management program. Cooperative inquiry and adaptive management practices should be built into a project from the beginning.
- *Consider the long-term requirements of the process from the very beginning of the planning effort*. It is all too common for a project to begin with a bang, and then disappear without achieving any of its major goals. Although short-term results are important for building support for a collaborative process, long-term objectives are needed to maintain the process over time. Progressing towards those long-term outcomes requires a management structure that promotes continuity among the project leadership. Perhaps most importantly, sufficient funding must be available to demonstrate strong commitment to the process by key partners, to provide incentives to partners for participation (for example, grants aimed at capacity building) and to keep the process going long enough for relationships to be built and solidified. It takes time and effort to build the process, and progress can be very difficult to document in the early stages. It is all too easy for a "catch-22" situation to develop – funding is needed to get results, but results are needed to get funding.
- *Focus on communication and learning during process evaluation, rather than on specific outcomes*. Both external and internal reviews are valuable. External reviews are effective at evaluating the quality of the science and the appropriateness of the methodology used. Internal reviews are important for steering the collaborative process. The California Bay-Delta Authority (CALFED) adopted a combination of internal and external review. CALFED, an adaptive collaborative management program, was established in 1994 to coordinate efforts to address numerous interrelated water management, ecosystem restoration, drinking water quality, and levee reliability issues in the Sacramento-San Joaquin River system

of central California. Although CALFED struggled to develop an effective comprehensive monitoring and assessment plan for evaluation of projects (Van Cleve et al. 2004), the evaluation process did contribute to the willingness of project partners to continue active participation.

The process of changing to a new management approach can be broken into three basic phases, each with its own design considerations and requirements. These include:

- Initiation and design of the new process: developing relationships, negotiating shared understandings and goals, prioritizing problems/issues; identifying potential interventions/actions.
- Implementation of new process: compare scenarios, select actions, monitor outcomes and evaluate actions.
- Maintenance of new process: assign long-term responsibilities, agree on penalties/rewards, continue "plan-do-check" cycle of actions.

Each of these phases is discussed in more detail below.

Process initiation and design changes in management processes are not likely to occur until and unless a majority of decision makers and stakeholders perceive that change is urgently needed in their particular system. "If it ain't broke, don't fix it" is a reasonable rule by which managers live, since any change carries with it costs and risks as well as opportunities. Even if all of the involved actors acknowledge the benefits of a change, there will need to be a compelling reason to pay the transaction costs (money, time, energy) needed to overcome the unavoidable "activation energy" barrier (the effort and political capital needed to develop and implement new policy). Therefore, although the ultimate goal of the process is to move from a reactive (problem response) to a proactive management (problem avoidance) approach, we must acknowledge that the change process is likely to be initiated in response to some triggering event or crisis (Birkland 1997). This event may be a disaster (natural or man-made), or an unexpected political or economic occurrence. The change process will begin when an influential individual or organization recognizes and responds to such an event.

Once agreement is reached that a change process is needed, a preliminary situation analysis should be conducted to determine if a collaborative adaptive management approach is appropriate and feasible. If there is no resilience in the ecological system or little flexibility among stakeholders in the coupled social system, it is not possible to manage either system adaptively (Gunderson 1999). This initial analysis involves two distinct aspects: a social/institutional analysis and an issue analysis. Questions that should be addressed in the social/institutional analysis include:

- Who are the key actors? Who has responsibility for what? Who needs to be involved in the change process?
- Do all (or at least most) of the key actors acknowledge that change is needed? The individuals and organizations must come to this decision on their own; change cannot be imposed from outside, although higher-level regulations can provide a context that encourages change.

- What resources are available for the effort? Are the key organizations willing to commit staff time to the change process? This is a key indicator that "the time is right" for change to occur.

  Questions that should be addressed in the issue analysis include:

- What are the major problems, issues, and constraints? What are desirable and undesirable system behaviors and states?
- Are there major gaps in knowledge and/or scientific uncertainty? Is the system of interest complex? Collaborative adaptive management is a strategy specifically concerned with making sound decisions in the face of uncertainty and complexity.

If collaborative adaptive management is both appropriate and feasible, the next step is to begin the *process of building trust and collaborative relationships* among the key actors. This stage is a very delicate one, because trust is often at a minimum at the start of the process. Thus, it is important that the initial relationship building be a facilitated process. A neutral facilitator, perhaps from a widely accepted boundary organization, can help the participants develop ground rules and serve as a mediator between actors divided by past problems. The particular role played by facilitator will vary according to the particular situation – the more contentious the issue or the weaker the institutions (for example, in a country with weak democratic traditions), the more critical the mediation function. In other cases, process management will be important (making sure meetings run smoothly, for instance). Mediation and dispute resolution practitioners have developed an extensive toolkit for this important capacity-building role (e.g., Adler et al. 2000; Susskind et al. 1999; and Andrews 2002).

An example of the value of trust-building exercises is provided by the experience of a science instructor (C. Turner, 2004, written communication) in the Bureau of Land Management Partnership Series course entitled 'Community Based Stewardship' held in connection with a forest management dispute in John Day, Oregon. Pre-workshop assessment indicated that the community felt an "us vs. them" sense towards the forest management institutions – the government was blamed for cutting people off from their livelihoods, and environmentalists were viewed with suspicion. This was confirmed during the first day of the 3-day course, as participants provided 'input' that was "emotionally charged and challenging to deal with." The participants indicated that the community had made several attempts to work with the Forest Service to reopen the forest, recognizing that old practices were no longer viable. They tried to build consensus for a plan, and each time, a single environmentalist would take legal action to stop a plan agreed to by most. On the second day, participants were asked, "what do you think of when you hear the word 'scientist'?" The answers were something of a shock to the instructors – "falsification of data", "agenda", and other expressions indicative of a perceived lack of objectivity.

The course included a number of group exercises that helped people discover the experience of collaborative problem solving. By the end, the group had reached a point where constructive dialogue was possible. A professional facilitator who lives in the community and knows the personalities, the issues, the economic deprivation suffered in the town, and the sense of hopelessness that had taken root, told the instructors that 'a major transformation has occurred in this community because of this course'. For example, it had been suggested to the community in the course of the class that they needed to keep trying to bring the environmentalists to the table, in spite of past experiences. One member of the community said "You know, we have environmentalists in our own town, but we're now so hostile to environmentalists that they won't step forward and admit it! We need to make it safe to be an environmentalist in this town." The course provided a "safe space" where participants could learn more about each other's motivations and values, and begin to re-think their negative assumptions and stereotypes.

Design of the participative process is critical to the success of a collaborative adaptive management effort. Beierle and Konisky (2000), in their evaluation of public participation in environmental decision-making in the Great Lakes region, found that successful participation was related to good deliberative processes with an emphasis on consensus, good two-way communication between participants and government agencies, and obvious government commitment to the process. Clear ground rules (guidelines for group behavior) can help to maximize the efficiency and fairness of dialogue and information sharing. The Consensus Building Institute, a non-profit organization that provides mediation services in complex public disputes, has found that these rules should: (1) define how decisions will be made (i.e., how is consensus defined, and what happens if there is no consensus on an issue); (2) clarify the roles and responsibilities of participants, mediators, the convener, and the public; (3) determine how participants should interact with each other; (4) explain how media inquiries will be handled; (5) describe how working groups or subcommittees will be used and their work integrated; (6) explain how draft documents will be circulated and reviewed; and (7) define confidentiality (if the process is not public). In addition, ground rules should have a contingency built in such that they can be changed upon learning more about what the group needs to interact effectively.

Process design must take into account the commonly overlooked fact that participation is a scarce resource (Andrews 2002). All potential participants – decision makers, managers, technical experts, formal stakeholders, and the general public – have limited time to spend on a collaborative process. Potential participants are usually very busy, with many important tasks competing for too little time, and a decision to do one thing may result in something else being left undone. A truly collaborative process will only develop if the agency seeking people's involvement demonstrates through careful process design that there is respect for and appreciation of the participants' time. An important design component is a clear connection between the collaborative process and actual policy development and implementation – people will not make the time to be part of a "dead-end" process that does not influence decision-making. For example, many (if not most!) opportunities for "citizen input," such as public hearings, are too divorced from the actual decision-making process to have any significant impact. In practice, an obviously inconsequential participative experience can do more harm than good, producing suspicion and resentment that discourages rather than encourages collaboration. Beierle and Konisky (2000) found that success in public participation efforts was highly related to the lead agency's commitment to the participatory process, as demonstrated by provision of adequate funding and staffing, lack of turnover, and sustained interest in the process. In other words, the leading agencies and organizations must demonstrate sincerity and commitment to the process in order for people to choose to participate.

6.3 Process Implementation

Once a management strategy has been selected, the participants must develop a detailed implementation plan. This plan should establish (1) who is responsible for every activity; (2) how each activity will be funded; (3) when and to whom progress reports should be delivered; (4) short- and long-term criteria by which the impacts and outcomes of the activity can be determined; (5) the schedule and protocols for monitoring activities, including specification of who will perform sampling and analysis; and (6) the schedule and list of participants for post-implementation review and evaluation. The implementation plan should include a conceptual model or description of the hypothesized cause-effect relationships that serve as the basis for planning (required for determination of evaluation criteria), a clear explanation of uncertainties, and a discussion of how actual outcomes might differ from expected outcomes. In short, the document should summarize current knowledge about the system structure and dynamics, and the management hypotheses based on that knowledge.

The implementation plan should address two objectives. First, of course, is the management objective – improved conditions, reduction in hazard, etc. The second objective should be to increase knowledge about system structure and dynamics. In other words, activities designed to address a particular problem or issue should also be designed so as to fill in knowledge gaps and to test cause-effect hypotheses. This second objective is important in setting up the information feedback loop that enables "learning by doing." Consideration of both objectives throughout the design and implementation process can greatly enhance both the cost-effectiveness and the chances for long-term success of management activities.

6.4 Process Maintenance

Successful long-term maintenance of a collaborative adaptive management process requires that responsibility be assigned to a specific individual or team, along with sufficient resources and authority. Without a "champion" to keep things moving, the process is likely to fade from participants' agendas and priority lists. The individual or team may work for the boundary organization, or for one of the participating agencies or organizations; the critical thing is that the participants jointly select the individual or team, and that all participants contribute in some way to the continuing management effort. These contributions, which may be in the form of funding, staff time, materials, or use of facilities, both help support the process materially and maintain direct and active links between the participants and the process.

The specific elements of a long-term maintenance program will vary with circumstances, but two elements should be central to any adaptive process. These are: (1) monitoring and evaluation, through which the effectiveness of management actions are tested; and (2) periodic policy review, during which policies and management decisions are modified in response to the results of the monitoring and evaluation.

A critical, arguably defining, characteristic of an adaptive process is formalized feedback mechanisms that use monitoring and evaluation of the effects of imposed management activities as criteria for modifying the management plan. Unfortunately, post-implementation monitoring is commonly inadequate or omitted. Once actions have been taken (implementation), the usual scenario is that the issue fades from public awareness, funding dries up, and the responsible agencies wish to avoid the negative consequences that might follow if monitoring exposes inadequacies in policies or implementation. Thus, it is important for the participants to make a strong formal commitment to monitoring and evaluation at the very beginning of the project.

Collaborative adaptive management also requires formal mechanisms for routinely incorporating lessons learned from management actions into policies and planning. Collaborative adaptive management requires more than simple data collection; the data are not useful until they are rigorously integrated, interpreted, and evaluated. Post-implementation review is almost always under-emphasized as a result of technical barriers, resource limitations, and strategy. For example, collection of data without careful consideration of analysis and review protocols commonly results in collection of data at a more rapid rate than they can be analyzed, and thus the data cannot contribute significantly to management decisions (Hoenicke et al. 2003). An important psychological and strategic factor that has limited post-implementation review is reluctance to acknowledge errors. Particularly in the litigious climate of the United States, organizations and individuals have a realistic fear that admission of error will lead to liability claims and legal challenges. However, learning from error is a central tenet of adaptive management, and the open recognition of error is crucial in the evaluation of management programs (Miller 1999).

Evaluation efforts typically concentrate on results or outcomes, such as changes in the abundance of a particular species or in the level of a particular pollutant in streams. While specific outcomes are certainly important, they do not provide sufficient information to guide a cooperative adaptive management process. Outcomes may be “valid as infrequent indicators of the health of entire systems,” but they are not useful for “making tactical decisions” or interpreting performance within shorter time frames (Schonberger 1996, p. 17) because the natural processes that we are concerned with operate relatively slowly compared to management timeframes, and there is likely to be a considerable time lag between an action and the environmental outcome. In order to manage adaptively, we need to provide decision makers with feedback on the effects of management decisions quickly enough to permit adjustments of plans and actions.

Social and economic pressures usually are the primary drivers of change in ecosystem conditions. Thus, evidence of human behavior change can be a useful leading indicator of progress. Evaluation efforts should also consider the institutions and incentives governing the implementation of policies and programs (Brinkerhoff 2002), including informal rules, regulations, controls, and structures (Squire 1995), all of which are crucial components of cause-and-effect linkages that ultimately lead to performance outcomes (Kaplan and Norton 2001).

The usefulness of the review process is largely dependent on the evaluation criteria selected. Design of an effective monitoring and evaluation program requires recognition that projects have multiple dimensions (biophysical, socio-economic, and institutional) and, therefore, multiple objectives (e.g., improvement in environmental conditions, maintenance or improvement of socio-economic conditions, development of institutional capacity). Long-term project maintenance requires monitoring across all three dimensions. A project that results in improved environmental conditions but creates hardships for people, which can erode political will, and friction among participating agencies and organizations, which can erode institutional capacity, will not last long or be very effective.

Clear goals should be articulated for each dimension, both in terms of outcome and process. For example, although the objective of a collaborative adaptive management process may be stated in terms of desired condition of the natural resource, the critical leading indicators of progress are those tracking the relationship building among the participants. Of course, relationship building is much more difficult to measure and track than are changes in resource condition. A list of potentially relevant attributes is provided in Beierle and Konisky (2000). They evaluated the success of public participation efforts against three social goals: incorporating public values into decision-making, resolving conflict among competing interests, and restoring a degree of trust in public agencies. The evaluation criteria (Table 1, p. 591) were based on a number of attributes, which the authors broadly divided into "context" and "process" categories based on how much control agencies and participants had over the attribute. These attributes can provide a starting point for developing appropriate evaluation criteria for an adaptive co-management process.

Setting up an effective review process for collaborative adaptive management requires consideration of several points. These include the following:

- Care must be taken in selecting the people who will participate in the review process. The participants need to have sufficient authority (and political protection) within their own organizations to successfully champion changes in policies and protocols. Participating agencies and organizations demonstrate their commitment (or lack of commitment) to the management process by their staff choices.
- Adequate resources need to be set aside for the review process.
- The process managers and the participants should make a real and continual effort to strengthen lines of communication, both among and within participating agencies and organizations, in order to complete the information feedback loop. Individuals differ in how they most effectively take in and relate to information,

so a variety of communication media and forums should used so as to connect with a wide range of people. Formal external review at regular intervals can greatly enhance long-term chances of success, both in terms of effective management process and sound science. A thorough review by a neutral party should be viewed by participants as providing valuable feedback on the adaptive co-management 'experiment', and as facilitating meta-organizational learning and adaptive improvement of the process.

7 Conclusions

> There will be a paradigm shift from approaches emphasizing optimal solution and control over limited temporal and spatial scales towards approaches emphasizing cross-scale interactions and living with true uncertainty and surprise. The emphasis should be on flexible institutions and human organizations that can build adaptive capacity in synergy with ecosystem dynamics and reward systems that respond to feedback.
>
> (Yorque et al. 2001, p. 435)

One consequence of the complexity of social-ecological systems is that good management practices can never become formulaic or 'by the book'. Change is a constant, uncertainty is a given, and the only thing we can count on for the future is that we will be surprised by it. If we are to make reasoned and informed management decisions about science-intensive issues, we must find a way to shift from an adversarial to a collaborative management culture, and to better manage the science-policy interface. There needs to be an ongoing dialogue between the providers of information – scientific, technical, and experiential – needed for understanding of the relevant system dynamics. A dialogue is a two-way exchange, a give-and-take in which both sides learn from each other. Typically, however, information tends to flow in only one direction, from the scientists and technical experts towards the decision makers and managers, and from them to other stakeholders. As a result, the information all too often does not answer the most pressing questions, is in a form that does not convey meaning to the participants, and does not get to the people who need it in time to be of use. Changing this dynamic will require careful attention to the management process, with particular emphasis on relationship building.

In the case of the U. S. Geological Survey's efforts to improve the science-policy interface, a particular question has come up time and again in discussions with USGS scientists about strategies for more effectively integrating science into the decision making process – how can USGS scientists both engage fully in the process and retain their reputation for objectivity and high-quality science? In other words, is it possible to be a participant without being perceived as an advocate? As articulated by Douglas (1995, p. 24), "If an agency uses scientists as advocates, credibility will, in the near term, be eroded, no matter the quality of the science… Scientists certainly can and should be asked to draw conclusions and make recommendations based on the evidence they have gathered. However, a line should be carefully drawn between explanation and advocacy, and between subjectivity and objectivity." Wagner (2001) argues that agency research is more likely to be objective if it is conducted at some administrative distance from the policymaking process, either in a separate division or other administrative structure, or carried out in an organization that does not have sole responsibility for setting policy internally. We suggest that the necessary administrative distance can be provided by use of the boundary organization approach (the use of neutral third-party science facilitators) and joint inquiry processes such as joint fact-finding.

Fully integrating science into the decision-making process does not mean that every scientific researcher and technical expert needs to be directly involved in collaborative interactions. Not all skilled scientists and engineers are good communicators, nor do they all have the time and inclination to attend many meetings. Whether or not they actually sit at the table, however, it is critical that all who are involved in the management process be willing to collaborate and be receptive to ideas beyond their own experience and special area of interest. All need to acknowledge that when it comes to understanding the behavior of complex social-ecological systems, no one (and everyone) is an expert. All participants bring useful knowledge and experience to the table, whether it is scientific, technical, traditional, cultural, local, or remembered, and every type of knowledge has standards of quality that can be examined, debated or shaped. A well-designed and implemented collaborative adaptive management process will improve the capacity of all participants to learn from different kinds of knowledge (Adler and Birkhoff 2002).

Scientists and engineers, by both training and natural inclination, are particularly prone to the tendency to focus more on outcomes – cleaner water, increased biodiversity, better quality of life – than on process. Unfortunately, in a complex and contentious world facing a multitude of intimately interwoven problems, 'outcomes' are ephemeral at best and often illusionary. We will not succeed in 'making things better' one outcome at a time. Instead, we need to change the process by which we interact with the world and with each other and to build bridges across the science-policy interface.

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Chapter 11
Adapting Participative Governance Framework for the Implementation of a Sustainable Development Plan Within an Organization

M. Merad, N. Dechy, and F. Marcel

Abstract This chapter will discuss how participative governance frameworks can also be an interesting approach for Organizations or Institutions targeting a sustainable development goal and how these frameworks can contribute to frame (more) collectively an expected equilibrium between reducing the impact of the economical activities on climate change and environment by maintaining economical growth and respecting social concerns. We will describe and discuss our empirical case study which objective was the implementation of a sustainable development plan within a public Institute. This case study will show the advantage of participatory frameworks and the limits of stakeholders' participation model in some specific contexts. The practical approach we designed will be introduced with reference to some theoretical frameworks (based on decision aid methodologies, stakeholders' theory and contracts theories). In particular, different levels of participation (information, consultation, association-participation, and deliberation-concertation), according to three models of democracy (representative, participative and deliberative), have to be distinguished before being used.

Keywords Governance • Sustainable development • Decision aiding • Participation • Deliberation

1 Climate Change, Sustainable Development and Participation

With the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, the Climate change problematic has moved from a scientific problem (International Panel on Climate Change) to a policy making challenge. The major

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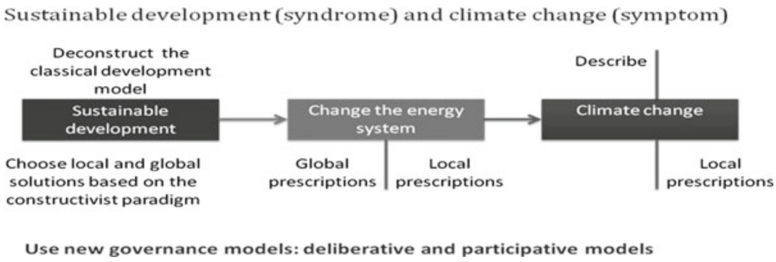

Fig. 11.1 Climate change problematic invites to rethink our societal development model

objective of this treaty was to stabilize greenhouse gas concentrations in the atmosphere at a reasonable level. France, as other countries has framed a national strategy to fight against climate change in 2006[1] and is at present framing a new national plan scheduled for the beginning of 2011. However, the majority of the discussions and debates, in the scientific and the policy making communities, dealing with the prevention and the fight against climate change are focusing on (i) the veracity and the uncertainties of the risks due to CC[2] or/and (ii) the local (territorial) measures that must be taken to mitigate the process or/and on (iii) the need to change the most used (fossil) energy system or the present industrial activity.[3] Most of these debates may have focused too much on some of the symptoms like the negative environmental impacts (ex. climate change, pollutions, accidents…), and it has been more widely acknowledged in the recent decade the need to address the root causes or the syndrome that is our development model which would require today to shift toward a sustainable development model. In most cases, it is observed a wider use of participative approaches and governance frameworks both for local and global issues. These institutional tools do not imply an automatic success to achieve collective agreements and compliance (Fig. 11.1).[4]

1.1 Governing Sustainable Development

In 2007, the French Government decided to change the way they had handled the environmental issues until now and launched six workshops named "Grenelle de l'Environnement" where the State, local collectivities, NGOs, companies and

[1]Observatoire National sur les Effets du Changement Climatique ONERC. (2006). Stratégie nationale d'adaptation au changement climatique. 97 pages. http://www.developpement-durable.gouv.fr/IMG/ecologie/pdf/Strategie_Nationale_2.17_Mo-2.pdf

[2]See for example *Climategate* accident in November 2009 where the IPCC panel was pointed as using questionable procedures to confirm their hypothesis about CC.

[3] See the debates in US about petrol reliance after BP Deepwater Horizon explosion in 20th April 2010 and its catastrophic consequences.

[4]See Kyoto protocol ratification, and more recently Copenhaguen forum failure.

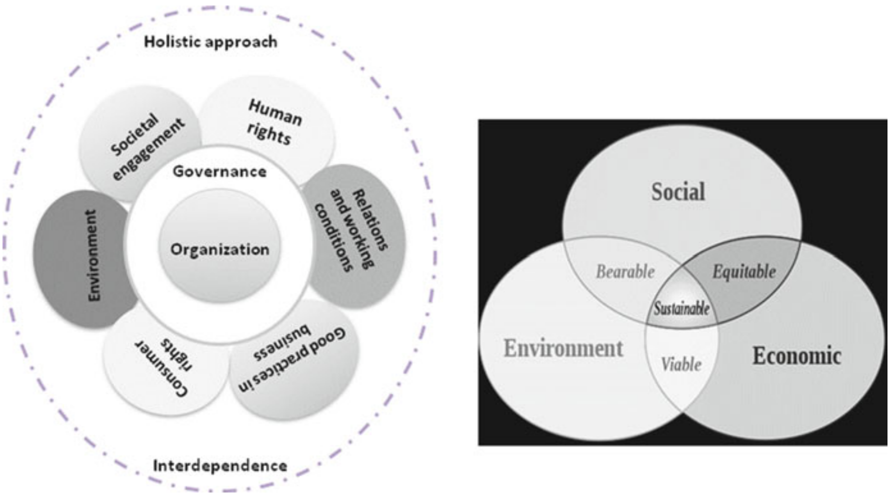

Fig. 11.2 Sustainable development model for a country (*right*) and for an organization according to the ISO 26 000 norm (*left*)

employees were involved in a large discussion. These participative workshops have fixed the basis of "Grenelle 1 Law of August the 3rd, 2009" that has confirmed the need to rethink globally our development model moving to a more sustainable one considering more and more the stakeholders needs and perceptions (social dimension).

In this law, the fight against CC is still considered as the first national challenge. But, both public and private Organizations were asked to consider more than this challenge in framing a so-called "Sustainable Development Plan" (SDP). Indeed, the major change in the Grenelle law is the way environment and risk concerns are handled within a new governance paradigm expected to facilitate the reach of equilibrium between environmental, economical and social dimensions (Fig. 11.2).

The title V of the Grenelle law gives instructions about "*governance, information and training*". The word "*concertation*" is abundantly used to refer to the need to "*consult and involve different stakeholders" and the need to "act in common*". Indeed, environment, safety, security, territories … are "*global common goods*".[5] That means that the common goods impact many parties, and they are themselves impacted and owned by different stakeholders.

The fact is that even if the law insists on the need of *stakeholders' information, participation*, *consultation or deliberation/concertation*, there still remains a blur in understanding what is expected by these processes and what are their limits and impacts on final decision-making. Indeed, these imprecision seem to hide a lack

[5] A large ongoing debate about "Global common goods" is about the *enclosure* by private ownership (Harding) or a *community management* of "common goods" semi-decentralized (Ostrom 1977) or global (Godard 1989).

of discernment between different level of stakeholders involvements on public decision process and final decision-making.

In what follows, we will firstly discuss about the distinctions between different levels of stakeholders' participation and secondly discuss about the methodologies that can be used to frame a common action and what are their underlying *democratical* principles.

1.2 Models of Stakeholders Participation According to Democracy Paradigms

Stakeholders' participation is nowadays used as a credo to regulate the relations between the stakeholders within the society and as a response to an ongoing public lost of trust against the policy makers and the scientists. Several reasons can be advocated to explain the need to use participation within public decision-making processes:

- The emergence of the information society within a knowledge sharing re-equilibrium between experts/scientist/policy-makers and other stakeholders.[6]
- The underlying uncertainty within science due to the abundance of controversies and scandals.[5,7]
- The need to legitimate or to give more credit to public decision-making.[8]
- The increasing public concern about environmental issue.
- A favorable legislative context.[9]

For these reasons and in order to fill the gap between the different stakeholders, different participations models exist.

Arnstein (1969) has suggested one of the first scales that differentiated the level of stakeholders' involvements. This scale is composed of eight rungs starting from

[6]See the collaborative work managed by IRSN with the participation of INERIS, AFSSA, INRA, INVS, ADEME and IFEN: Report "Experts et grand public: quelles perceptions face au risque?" Published in February 2007.

[7]See the Risk communication and government. Public and regulation affairs. http://www.inspection.gc.ca/english/corpaffr/publications/riscomm/riscomm_ch1e.shtml

[8]See the Quel horizon pour les sciences de gestion ? Vers une théorie de l'action collective *in* Les nouvelles fondations des sciences de gestion. Collective book coordinated by David A., Hatchuel A., Laufer R., pp 7–43. Vuibert Edition and LAUFER R. (1996). Quand diriger c'est légitimer. Revue Française de gestion, vol.111, pp. 12–37.

[9]See the different laws and conventions like: the Aarhus conventions in 1998 about the right to be informed and involved as citizens in problems dealing with environmental concerns and the 2000/60/CE water directive. In the French context: 95–102 law about environmental protection, 52–1265 law that has instituted the need for dialogue between the State, territorial collectivities and the project manager, 2000–1208 law about solidarities and urban renewal about Local land use planning and more recently Grenelle I and II laws.

8	Citizen control	Effective empowerment of citizen
7	Power delegation	
6	Partnership	
5	Reassurance (Placation)	Symbolic cooperation (Tokenism)
4	Consultation	
3	Information	
2	Therapy	Non participation
1	Manipulation	

Fig. 11.3 Citizen participation scale according to Sherry Arnstein (1969)

"manipulation" to "citizen control" (Fig. 11.3). The bottom rungs describe non participation models where the real objective is to enable power-holders (ex. policy makers, scientists…) to educate the other stakeholders. From the rungs three to five, stakeholders are allowed to have a voice within the decision making process. The effective empowerment of citizen or stakeholders started beyond the rung five where there is a possibility of negotiation and a potential impact on final decision-making.

In echo to this classification, we would insist on the importance of two variables to distinguish the different levels of stakeholders' participation:

1. ***The impact level of stakeholders' participation on the final decision making.*** This represents the ability of stakeholders to both influence the framing of the decision making process and to see their opinions included in the final decision-making.
2. ***The level of equality between the decision-maker (DM) and other stakeholders.*** This aspect is distinguishing the situations where the DM is considered as having more power and/or more scientific, technical or charismatic relevance in the framing of the decision-making process and on the final decision-making.

These two scales helped us to distinguish four models of participation: information, consultation, association and deliberation (Fig. 11.4) that we explain and discuss hereafter.

By distinguishing these four models, it can become clearer that when policy makers use the word "participation" they do not always refer to the same meaning. That can explain the vagueness done to the word "concertation (participation)" done within the Grenelle I law for example. Indeed, different participative frameworks can be distinguished using the typology suggested in Fig. 11.4.

Public inquiries and *public opinion studies* for example are frameworks where stakeholders opinions are considered as important to know for the DM but not always

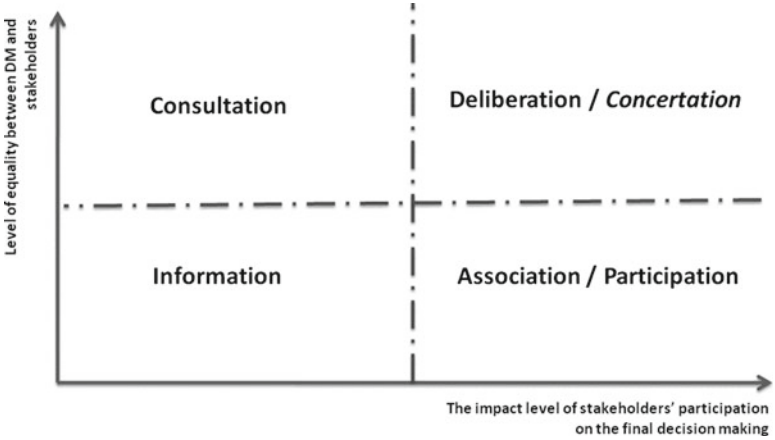

Fig. 11.4 Four level of stakeholders' participation

significant to considers and then do not impact directly the final decision making. These frameworks of participation are "information models". In France, Local Committees of Information and Exchange (CLIE) are information structures even if the term "exchange" suggests more than that.[10] *Focus groups* and other *citizen panels* are based on "consultative models". The difference between the *information structures* and *consultation structures* lies in the fact that the conclusions resulting from the closure of these structures are considered during the public decision making processes but not necessary used in the final decision making. In these structures stakeholders are all invited to express their opinions and share their concerns without making a hierarchical distinction between them.

Participation/association is here considered as different from the *consultation* and the *information* in the fact that they are done for a final DM but the conclusions of the stakeholders are considered only as recommendation, which means that they influence the final decision-making even if they are not the final decision maker. Grenelle workshops organized in 2007, or negotiated rules making for example correspond to this definition (Fig. 11.5).

In *Nicomachean ethic*, Aristotle define *deliberation* as *a process among several individuals that help thinking things over and that come at the end to a collective decision-making*. In fact, in this last category of stakeholders' participation, stakeholders have all the same power and influence both the process and the final decision-making (Fig. 11.5): *cooperative* structures can be an example of this last but not least model of participation.

[10]To know more about this structure: Implementation of local committee in the vicinity of industrial Seveso sites, France. Proceedings of the international seminar "RISK: perception, communication, acceptability". 3–4 October 2005, Bruges, Belgium, pp. 47–66.

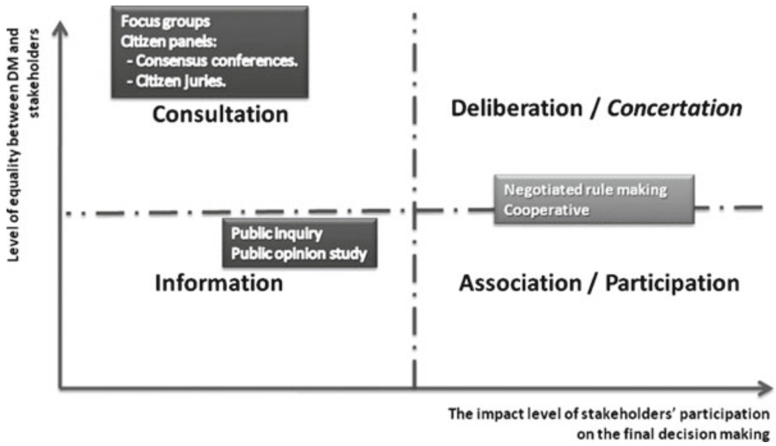

Fig. 11.5 Example of participative frameworks

The expression of democracy in public decision-making is based on the way these four stakeholders' participation models or governance models are declined in practice. In fact, we can identify three governance models based on different expression of the democratical paradigm:

- ***The representative democracy.*** This is one of the most known models of democracy defended by Max Weber and Joseph Schumpeter (see Held 1987; Renn et al. 1995). The basic idea of this model is that citizens are represented by elected political elites or selected scientific or administrative persons. These elites have the right and the legitimacy to influence and be involved in the public decision making processes.

  This model is the most used one when dealing with environmental or safety concerns within territories and it is also the case within Organizations. In fact, the working conditions are contractually fixed within the Organization subjecting employees to subordination relation (Fig. 11.6).

  In this model, the stakeholders can be informed or consulted about ongoing decision but cannot influence the final decision.
- ***The participative democracy***. Jürgen Habermas (1987, 1992) has significantly contributed to this concept. For him, all stakeholders can give significant information to enlighten the decision-making process. Each stakeholders carried out this own values, models, cultures … Participation can help stakeholders to understand themselves and to build a consensus. Habermas has insisted on the importance of the *communicational action* and the *dialogic reason* in creating the *consensus*. This model of democracy goes beyond the representative democracy model, in the fact that it offers a possibility to the stakeholders to influence the final decision (Fig. 11.7).

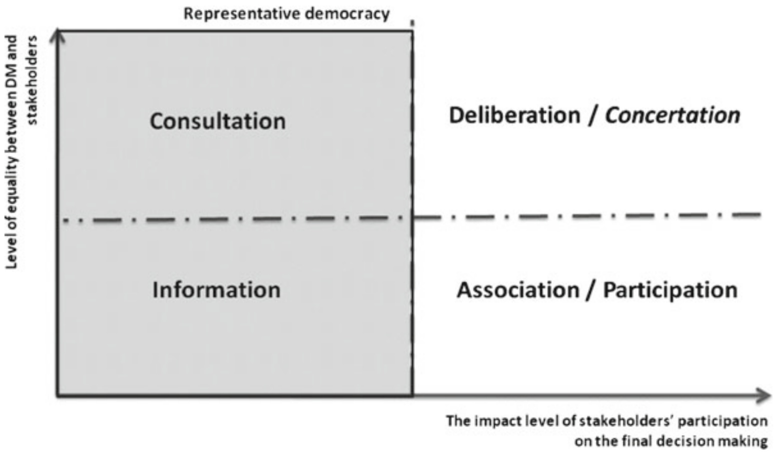

Fig. 11.6 Representative democracy

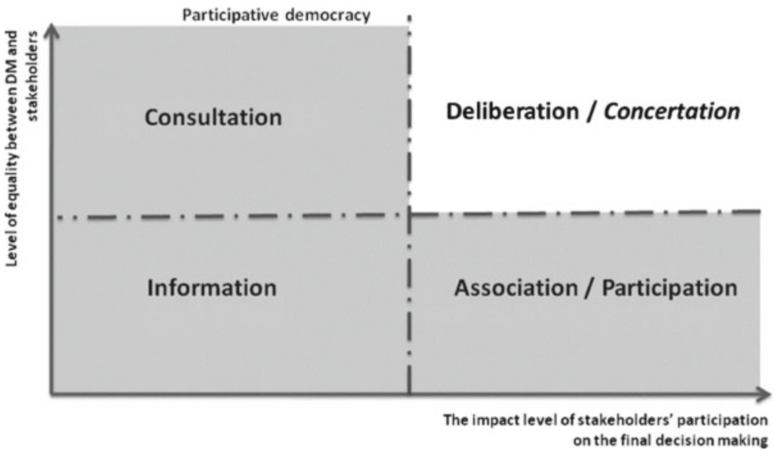

Fig. 11.7 Participative democracy

In France, some authors have insisted on the fact that participative democracy cannot be applicable within territories or within the society if Organizations continue to be a monarchical system (Fig. 11.8).[11]

- ***The deliberative democracy***. This model is based on the need to go a step forward participative democracy model by giving a real opportunity to deliberation all along

[11] See Marc Sengnier. (1905). L'Esprit démocratique. Paris. Perrin. In France, the first step to introduce a counter-power within the organizations started with the law of 1884 called Waldeck-Rousseau law that authorized the trade unions actions.

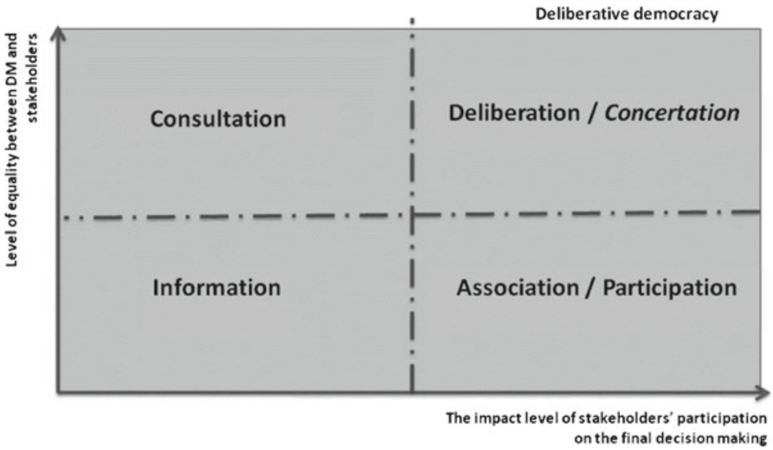

Fig. 11.8 Deliberative democracy

the decision making process and influencing the final decision. Deliberation is not only used to let stakeholders and DM understand their own point of view, but also to influence the final decision-making and to create the conditions for a proactive democracy in the sense where each stakeholder is a decision-maker by itself.[12]

One could wonder how these three models of democracy are translated in practice and are implemented to frame a common decision-making process and reach a common decision?

2 Decision Aid Methodology and Stakeholders Participation

By decision aid activity, we refer to "*the activity of an Analyst (facilitator, mediator…) that is mandated by a DM and/or different stakeholders to go beyond the possible conflicts or/and create consensus by mobilizing the information, the knowledge and the preferences of each involved actors. When trying to frame common conclusions and recommendations, the Analyst should use sounded scientific methods and tools to avoid intuitive and/or cognitive bias.*" This constructivist approach to facilitation and/or mediation activities is based on different methods and tools framed according to different models of democracy (see the Table 11.1 below).

Using Multi-Criteria Decision Aid (MCDA) methodology can help the implementation of the participative democracy model in the sense of going forward a

[12] To read more about this model, read Pierre Rosenvallon in "*La contre démocratie. La politique à l'âge de la défiance*", Seuil, 2006. Points-Essais, n° 598, 2008 and Joshua Cohen with Joel Rogers "*Associations and Democracy*", London, Verso, 1995.

Table 11.1 Decision analysis tools according to the three models of democracy

	Representative democracy	Participative democracy	Deliberative democracy
Authors	Max Weber and Joseph Schumpeter	Jürgen Habermas	Joshua Cohen and Pierre Rosenvallon
Value of information	• Identify and use stakeholders' information • Representativity • Precision	• Participative approaches: dialogic reason, communicational action (consensus building) and strategic action (manipulation) • Value polytheism (different model, cultures,…) • All stakeholders give an important information • Give a typology of validity conditions: Intelligibility, Scientific truth, Normative accuracy and Sincerity	Deliberation ≠ Discussion • How to build proactive democracy? • Counter-democracy – distrust politic
Decision analysis methods and tools[13]	• Decision-maker and analyst • Other stakeholders • Problem: choose the right model considering uncertainties on data (mathematical problem) • Models: Operational Research, MCDA (Choquet integral …)	Decision-maker and analyst Other stakeholders • Problem: frame problematics and choose a model (multi-criteria aggregation, BNW…) • Models: MCDA (inter-active, Outranking like ELECTRE …)	Problem: role of the decision analyst, frame reflexive approaches
Condition of validity	Model (data uncertainties)	Process	Empowerment

[13] To get more details about these approaches see Merad M. (2010). *Aide à la décision et expertise en gestion des risques.* Editions Lavoisier.

more transparent process (accountability principle) and avoid both intuitive and collective biases.

This methodology is based on both a descriptive phase and a prescriptive one. Some typical practical questions can be shown to support these phases.

- Descriptive phase:
  - For whom? (Level of decision? Stakeholders?)
  - Why? (law, …)
  - Who is also concerned by this information?
  - Who decides?
  - Who will be impacted?
  - Who will be in charge of collecting the information?
  - What are the objectives?
  - What must we assess?
  - What next?
- Problem structuring:
  - Mathematical formulation.
- Frame final recommendations:
  - What must we consider at first?
  - Is it robust?
  - What about legitimacy?
  - Does it work?
  - Are we satisfied?

In what follows, we will describe the different steps of multi-criteria decision aid methodology.

2.1 Multi-criteria Decision Aid Methodology for the Implementation of the Participative Democracy Model[14]

As pointed out below, the methodology is based on a two-step approach. The first step consists in "outlining and structuring the problem". To do so, one must identify what is at stake, the constraints, the actors concerned or affected, and to choose the appropriate method according to the level and the nature of information and knowledge. The second step is the "implementation of a method". This step consists in restructuring the available information according to the method to be used and

[14]This section is based on works submitted to publication in a paper entitled "Using a multi-criteria decision aid methodology to implement sustainable development principles within an Organization" by Merad et al. (2010).

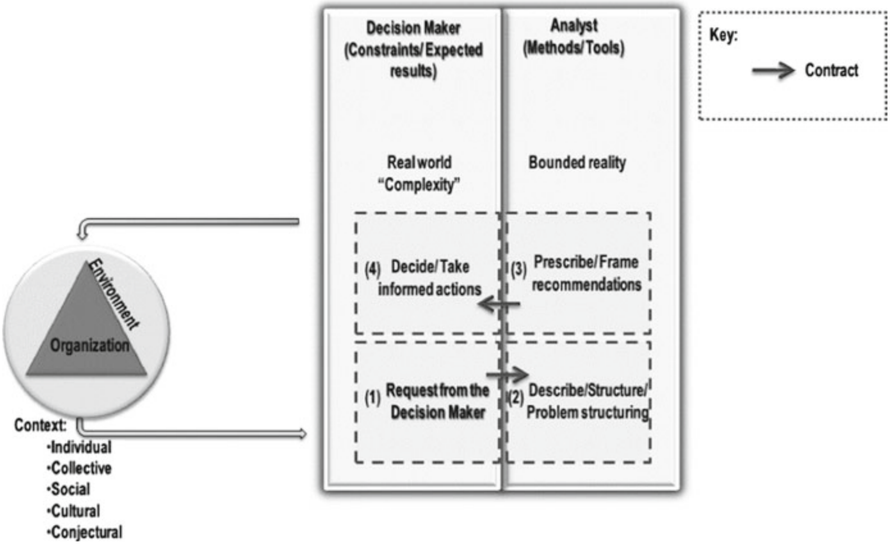

Fig. 11.9 Multi-criteria decision aid methodology: the link between the analyst and the decision maker

analyzing the results of the method in order to provide the adequate recommendation to the decision-maker. The figure given below describes these two steps.

The problematic of "Description and structuring" (Fig. 11.9, point 2) in building participation is a challenging problem. We have chosen to use an Organizational Analysis (OA) technique crossed with a "contextual diagnosis" to describe the SD problem. These two techniques are imported from social sciences and helps to make explicit what is at stake and what are the rationales between actors inside and/or or outside of the Organization.

1. **About the use of Organizational Analysis (OA) on structuring problems**
   OA helps in making a diagnosis about a system state or dysfunction/pathology (e.g., organizational change) before prescribing a remedy for an obvious symptom (e.g., implementation of mitigation measures to fight against climate change). It is a way to access also to the rationale or sense making and to understand the underlying conditions of the expertise of the organization's actors. The Analyst thus makes an effort at the same time by contextualizing (to circumscribe) pathology (Dechy et al. 2010) by giving a causal (influencing factor) explanation of a reported dysfunction and at the same time by de-contextualizing by highlighting the "reasons" of the emergence of the latter.

   By widening the range of problems identified initially by the Decision Maker (DM), OA re-interrogates methodologies and the conditions of investigation. Thus, the OA reintroduces the creative idea of a "case study" to the observational sciences through the "history of problems". The "history of problems" is the result of an interpretation, a judgment, or "giving sense to" of an investigator, of an entire set of reported experiences, experienced or perceived by operators, management staff, etc. "Giving sense to", suggested by the OA, is made possible by using:

- "Method of investigation" and exploration of the Organization.
- "Network of theoretical concepts" giving intelligibility to "pathological episodes" reported by the actors of the Organization.
- "Method of analysis", interpretation of the facts experienced by the actors of the Organization.

"Giving sense to" is based on both the *perceptive aspect of the judgment* of the investigator and the "conditions of validity" of the reported facts and expertise given by the actors according to their experiences within the Organization.

We can thus argue that the OA helps to go beyond the individual evaluation to a more collective evaluation of one situation with a better understanding and knowledge of the underlying rationale of these assessments. This points the delicate problem of *scientific objectivity*. With respect to this complexity resulting from incomplete information and even evolutionary partial knowledge, the investigator adopts an attitude of choice: "*one does not construct what he chooses, but chooses with what he uses to construct*".[15]

Once the context is described and better understood after some investigations, the Analyst should (and is in better position to) move to a prescriptive model (Fig. 11.9, point 3). MCDA is an interesting methodology that can help the Decision Maker (DM) in respecting the accountability principle that is a challenging aspect when dealing with sustainable development.

2. **Multi-criteria decision aid methods: general principles**
The great majority of decision aid methods tend to structure the decisional aid process into three principal phases: *formulation of decision-aid problematic*, *exploitation*, and *recommendations* (Fig. 11.10). Formulating a decision-making problem consists in finding an *adequate model for the decision-making process*. In a context where reality is represented by a multi-criteria form, this first phase consists in:

- describing the decision making context and process. This requires the identification of the actors, their value systems and the different significant points that affect the decision making process which can vary in time;
- defining the actions that are elements of decision-making;
- identifying decision making situations which consists of looking at how the recommendation or the results should be presented; and identifying the spirit in which the decision aid process was designed;
- modeling the consequences of actions and drawing up criteria in order to compare the different actions with each other.

This first phase is undoubtedly the most delicate one because the conclusions reached and the recommendations provided depend on the objectives reached by the

[15] "*il ne construit pas ce qu'il lui plaît, mais il choisit ce qu'il lui plaît de construire*". La création scientifique. Genève: Université de Paris, Ed. René Kister.

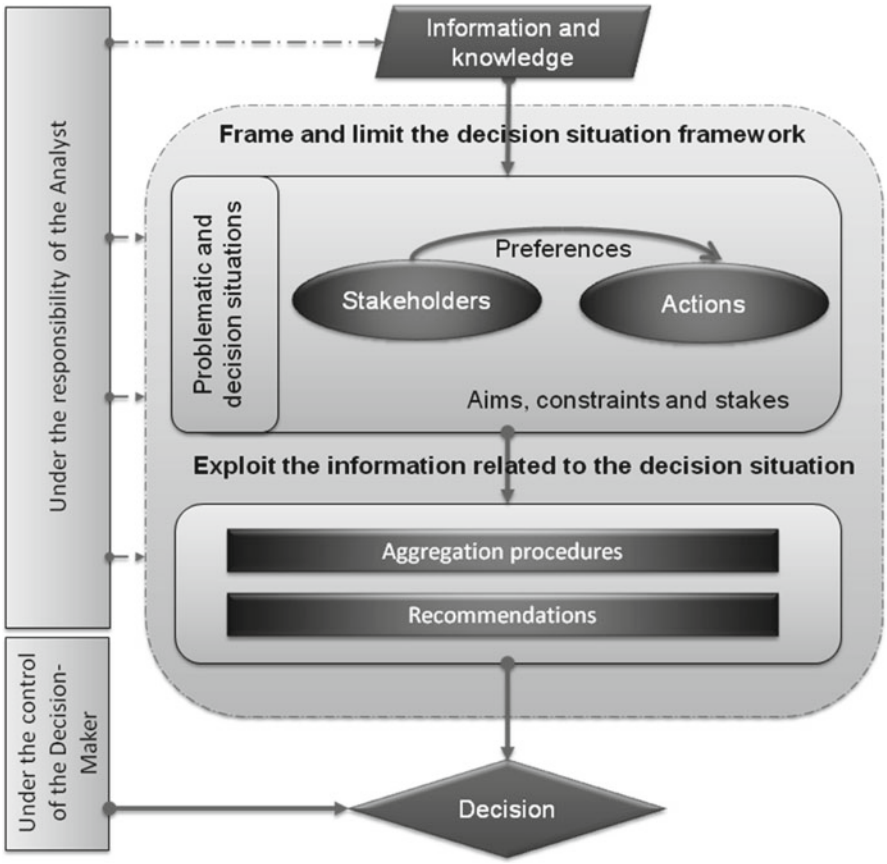

Fig. 11.10 Multi-criteria decision aid method applied to the implementation of a participatory process (Merad 2010)

implementation of a participatory process. The second phase is more mathematical (see Merad 2010). The so-called operational phase consists of defining or choosing an "aggregation procedure" for the available information for each action with the aim of reaching an overall conclusion (recommendation) that will serve to lend support to the decision.

- *Actors (actors/shareholders/parties) and Decision Makers*

  Various actors are concerned and involved in and/or impacted by a participative process: the actors who ordered the implementation of the process, the people in charge of the process, the experts and also various corporate entities or private individuals directly or indirectly involved. As a result, the implementation of a participatory process is conducted in interaction with those who in the decision-making process are called *actors*. It is interesting to note that the concept of the "actor" in MCDA is neither absolute nor neutral; this presupposes the presence of an observer (*investigator/analyst*) who, based on their modeling of the subject of the participatory process, produces a representation of the explicit or implicit distributions of roles to all of the parties.

Actors are split into five groups depending on whether or not they hold any power or stake over the final decision (decision makers), whether their intervention directly conditions the implementation of the participatory process (parties involved), whether they are subject to or intervene indirectly in the study (affected by), whether they intervene indirectly but are not affected by the consequences of the decision made (ghost or latent actors), or whether they are intermediaries (study requesting party or customers, investigator or analyst, advisor, negotiator, referee, informant).

- *Potential Action Concept*

In our context, an "action" is what the participatory process covers and can consequently be found under various headings such as: solution, project, etc.

Action is termed *potential* when it is interest worthy or when it is possible to put it into execution; nothing stops the action from being fictitious. If an action excludes, when it is performed, all other actions, it is referred to as being *global;* if not, the action is said to be *fragmented*. It should be noted that the definition of the complete set of actions can be set out *ahead of time* or *progressively* during the implementation of the participative process.

- *Preferences and Criteria*

Implementing a participative process aims at framing collective actions within a territory or within an Organization. In each level of decision, different actors coexist having different backgrounds, know-how, priorities and constraints which together form or will form their preferences.

Every actor's point of view (criterion) must reflect their preferences and allow the evaluation of the identified actions. In this case we refer to evaluating the performance of an action on criterion. A scale (*ordinal* and *cardinal*) is assigned to every criterion.

- *From a Partial Evaluation to a Global Evaluation: Aggregation*

Aggregating the evaluations of an "action" taking into account the evaluations of the different criterion and opinions on the importance that each actor gives to the family of criteria is also a way of asking the question of *compensation* levels that one wishes to obtain between the criteria.

Multi-criteria decision aid methodology was applied to problematics in the field of environment, safety and security within territories[16] and within

[16] See Merad et al. (2003). Use of multi-criteria-aids for risk zoning and management of large area subjected to mining-induced hazards. Tunnelling and Underground Space Technology, 2004, vol. 19, n° 2 and Merad et al. (2008). Urbanisation control around industrial Seveso sites: the French context. International Journal of Risk Assessment and Management - Issue: Volume 8, Number 1-2/2008 -Pages: 158–167.

Organizations (Merad 2010). In what follows, we will present the case of the implementation of a Sustainable Development (SD) plan within a public Institute (Merad et al. 2010a, b, 2011).

3 Framing a Sustainable Development Plan for a Public Institute

INERIS is a public institute in the field of industrial environment and risks, and works as a technical support for the French ministry of sustainable development which has oversight on ecology, energy and transportation. As a public institute, INERIS must be exemplary when it comes to the implementation of the SD principle. Indeed, INERIS started the roots of progress really early, among them:

- Since 2000, the Institute has been ISO 9001 certified and it regularly widens the field of its recognitions relating to the quality of its services: accreditation NF IN 45011, ISO CEI 17025, Good laboratory practice…
- In 2001, the Institute signed a deontology Charter formalizing the ethical values shared by the whole of its personnel and guiding it in its missions.
- In 2007, INERIS signed the Charter of public expertise with other public organizations, thus posted its engagements to open its expertise to other share parties as NGOs. Since then, INERIS has multiplied the organization of institutional events with other stakeholders of the civil society.
- In 2008, INERIS also signed, with other public organizations, the Sustainable Development Charter. This one reinforces the engagement of the Institute in favor of the SD principle.
- In a letter addressed to INERIS on April 6, 2009, the French Ministry of SD invited the Institute to frame a Sustainable Development Plan (SDP). In this SDP, the Ministry asked to:
  - identify some strategic objectives,
  - list a set of actions respecting three priorities (responsible sourcing or purchasing, eco-responsibility, social responsibility),
  - identify a set of indicators to follow the execution of the actions at an operational level.

Even if the SD principle has been known and defined since 1987 in the Brundtland reports, it is quite innovative for French public Organizations to make explicit and rationalize a set of actions that will be followed each year, and contribute to SD, considering economic, social and environmental aspects.

The General Director of the Institute decided to mandate a delegate for SD that is both a facilitator and a project manager. This SD' delegate was in charge to fit with the expectation of the Ministry of SD and conduct a participative process involving both the employees within the Institute and consulting different categories of stakeholders in direct or indirect relation with the Institute.

The participative process was here considered as an initiator for organizational change. Before starting the participative process, it was necessary to map the different categories of stakeholders and actors. We have identified four categories of actors (stakeholders):

- *Final Decision-maker*:
  - Ministry of SD that asked for a SDP.
  - General Director[17] that will undertake the responsibility of the SDP and is the Decision-Maker (DM) within the Organization.
- *Actors that are in charge of or directly impacted by the SDP*:
  - Staff of top managers within the Institute that will be in charge of the management and the control of the implementation of SD actions.
  - Operational staff that is composed by:
- employees that will be in charge of executing the actions and giving information to their manager;
- employees that have created for several years an informal group of discussion about the environmental impact of the Institute.
  - Representative of the employees within the Institute that must be regulatory consulted for all organizational change within the Institute.
- *Actors that are indirectly impacted by the SDP:*
  - Neighbors that are in the territories near the Institute that will be indirectly impacted by the SDP.
- *Actors that influence indirectly the framing of the SDP*:
  - NGO. Some of them are involved in the Board of the Institute some others are well known in France for their competences in the field of environment.
  - Public establishments that have the same constraints in the field of SD fixed by the French Prime Minister and their supervising Ministry.
  - Corporations that publish each year a SDP.
  - Exemplary municipalities that have carried out an Agenda 21.

It was impossible, within the available resources (time and money), to involve every stakeholder at the same level. In addition, some had to be consulted or implied (power and political reasons). Others were targeted for benchmark reasons. Therefore, it means that several process of participation have been used with the different actors (Fig. 11.11).

[17] The General Director is nominated by decree by the government.

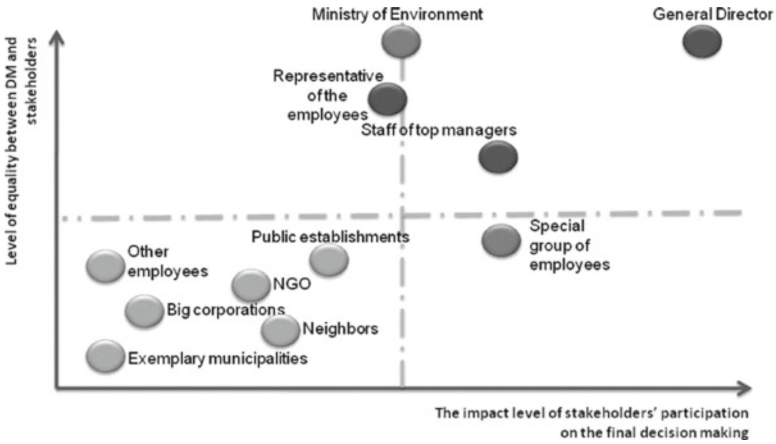

Fig. 11.11 Stakeholders' involvement in participation processes within the framing of sustainable development plan

That is why, and according to the stakeholders mapping that represents the type of participation process they have been involved in, we have chosen to:

- *carry out series of interviews* with the categories of actors that influence indirectly the framing of the SDP or that are indirectly impacted by the SDP. The objective of these interviews was to identify the expected actions that could be considered in the SDP in a benchmark perspective or good practices sharing. More than 200 actions were identified after the analysis of the interviews;
- *consult the employees and their representative* in the identification of a set of actions that should be considered in the SDP but also to identify the means, stakes, risk and benefits that can occur by the implementation SDP' set of actions. An organizational analysis was conducted to identify the potential risks perceived by the employees;
- *animate debate with the staff of top managers and the General Director* to select a set of actions that must or should be considered and implemented within the SDP, to identify a set of criteria that help the assessment of the level of SD benefits and expenses for each action and rank the set of actions from the first to implement to the last to implement within the Institute.

After the consultation and the debate phases, the set of 200 actions was first reduced to 48 actions and then to 22 actions that respect the constraints made by the Ministry of Environment (Merad et al. 2010a). The reduction of the number of actions was ordered by the General Director of the Institute. Indeed, even if the principle of participative democracy within an Organization is tempting, it is difficult to go beyond the expectation of a Final DM (see Sect. 1.2).

Actions to implement SD principle within the INERIS Organization are those which contribute to the improvement of the equilibrium between environmental, social and economic constraints. Each of the 22 actions is under the responsibility of the top management staff within the Institute. Each top manager has a different role and perspective but share common tasks that consist in seeking a financial equilibrium of their Division and defining a strategical vision.

Criteria (see Sect. 2.1) were identified with the staff of directors. These criteria represent a common framework to discuss about the hierarchy between the 22 actions and compare one action to the other according to the different available points of view. Two sets of criteria were asked to be necessary:

- Expected benefits (social, environmental and economical) due to the implementations of the SD actions.
- Necessary expenses (3 categories of expenses in k€) due to the implementations of the SD actions.

The choice of criteria-specific weightings has required the formalization of the preferences and point of view given by the staff of Directors. We have chosen to use the ‘cards method’ to explicit the different set of weights.

By conducting a set of interviews within the staff of Directors, it was possible to fill out the SD actions dashboard. Each action is coordinated by a Director. Each Director gives an estimation of the SD action according to the two sets of criteria. These assessments are carried out once per year and synthesized in “Impacts SD dashboard” and consolidated in a collegiate way.

In the case of the implementation of the SD principle within the Institute, the conflicts are not particularly between stakeholders but more about trade-offs between complementary and sometimes antagonistic concerns (environmental, economical and social). That is why we have chosen an out ranking aggregation procedure (Merad et al. 2010b) to order the 22 SD actions according to these conflicting criteria. At a strategical level of decision, most of the available information is qualitative due to the need to frame a common representation of the strategical objective of the Institute once the actions are identified and the criteria specified. The more adapted multi-criteria aggregation method is ELECTRE methods and more specifically ELECTRE III. Each action is compared to the others according to the set of criteria defined and submitted to debate to the staff of Directors.

A SDP was sent to the French Ministry of Environment in June 2009. This Plan was the first one to be framed in a participative way within public establishments.

4 Discussion and Conclusions

After a long period of skepticism on the advantages of stakeholders or citizen participation within environmental and risk problematic, these concepts became *la panacée* and a *sine qua non* condition to a good public decision-making process. Many advantages were pointed out about the stakeholders participations (Van den Hove 2003): *substantive advantages* (sharing information and knowledge can only be a beneficial process), *procedural advantages* (the quality of decision-making process is increased by avoiding conflict, giving more legitimacy and transparency to the decision-making process) and other advantages that influence *the contextual social context* (confidence between stakeholders, responsibility and increasing the participation culture). These advantages are offset by practical inconvenient such as for example: the *cost* of the implementation of a participative process, uncertainties on the efficiency of this approach, citizen and stakeholders disinterest and distrust on this approach (Rosenvallon 2006; Rowe and Frewer 2000).

Indeed, it became more or less required to use participative processes and governance frameworks to develop and implement a SD plan for an Organization. These institutional procedures were not much in use within the Organizations. But at the beginning of the SD plan project, we have identified three reasons why we could assume that it would be suited to import those frameworks to carry out an organizational change. The first reason, is that SD is bringing new stakes and new stakeholders that should be integrated at some stages in the decision making process (see ISO 26 000, *Grenelle de l'environnement* in France). The second reason is that those frameworks are based on *a constructivist approach* and fits very well with an innovative project such as the design of a SD plan. It helps to avoid a technocratic approach. Indeed, there are few benchmarks and good practices. Therefore values, preferences, opinions and new ideas should be integrated in the framing of the performance criteria. In this context, a multi-criteria approach was also chosen to support the participative process and the decision making. The third and last reason is a strategic trade-off on a *diachronical dimension* in the conduct of an organizational change. Indeed, participative process may foster its acceptability and avoid a future reject of the SD plan.

The practical experience has confirmed those assumptions but in the end there are a few limits. The main one is that in an Organization there remains a final decision-maker and there is no *co-decision* despite the participative process. It means also that the criteria and actions of the SD plan are influenced by the representation of the final decision-maker. We have observed a strong historical and cultural influence of environmental and climate change issues in what constitutes today the SD principle.

In this chapter, we have also shown practically that stakeholders' participation can be implemented in different ways according to the implicit democratic model. Different participation processes (information, consultation, association-participation and deliberation-concertation) have been conducted for different stakeholders and at different stages of the SD plan design process.

We have also seen that if deliberation and participation are upstream processes to the decision-making, it is necessary to think about the way these moments must be framed and organized to make it became as efficient as possible. Beyond the organization of dialogue meetings, it is necessary to wonder about the emergence of a new kind of actors: the expert, the facilitator and the mediator. These actors have the ability to prevent, avoid and/or clarify potential conflicts that can emerge due to the plurality of stakes and to the complexity of the technical and procedural aspects of stakeholders' participation. Various approaches, sometimes qualitative and sometimes quantitative, can be used considering the relation nature between different actors.

In France, stakeholders participation is strongly regulated and is strongly dependent on the various laws, decrees and circulars which define the moments, the methods and the framing which must cover these times of exchange and coordination between the various actors when dealing with environment and risks. This context makes the practice of participation difficult to implement within the Organizations and within the territories without experience and/or facilitators. We have in this chapter shared an example of the implementation of a participatory process to frame a sustainable development plan within an Organization.

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Chapter 12
Values in Natural Resource Management and Policy

David Mattson, Herman Karl, and Susan Clark

Abstract Values are considered by many people to be central to human interactions, yet the meaning of "values" is rarely clear in most applications. We offer our thoughts on how values might be usefully construed in a policy context, with relevance to design and appraisal of social and decision-making processes. We differentiate values from preferences, attitudes, worldviews, and interests because of the extent to which this surrounding field of concepts has been contested by sociologists and psychologists, and to highlight the comparative utility of focusing on values. We find it useful to apply the term "values" to the fundamental and abiding non-linguistic ways that people orient to the world, arising from antecedent attraction. Shalom Schwartz and Harold Lasswell developed values schema which, when used together, constitute a powerful frame for generating insights about human behaviors and decision-making in specific contexts. Schwartz posited the values of universalism, benevolence, self-direction, stimulation, hedonism, achievement, power, security, conformity, and tradition. Lasswell posited the related values of rectitude, respect, affection, enlightenment, skill, power, wealth, and well-being. We illustrate the utility of a values frame through an appraisal of social and decision-making processes in the Glen Canyon Dam Adaptive Management Program.

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1 Background and Approach

Most scholars of natural resource management and policy claim that values are central to human interactions. Yet in many writings the exact or even general meaning of "values" is rarely clear, other than related in some way to human motivation outside the realm of rationality. Given the apparent centrality of this concept, we see merit in striving for a more or less shared and stable notion of values to undergird inquiry and communication. But we also see merit in drawing on multiple frameworks to capitalize on the best each has to offer, to cover relevant human experience more comprehensively, to capture superior nuances of emphasis, and to provide adequate conceptual scope.

We offer here our thoughts on how values might be usefully construed in a policy context, emphasizing schemes developed by Harold Lasswell (1948) and Shalom Schwartz (Schwartz and Bilsky 1987), with reference to Abraham Maslow's notion of a hierarchy of needs (Maslow 1954). We feature Lasswell's scheme, but do not intend to subsume any scholar's work within another's. We see strengths and weaknesses in all the featured concepts and seek to highlight the strengths, identify the weaknesses or gaps, and clarify similarities. We do not imply equivalence where we identify similarity, but rather we cross-map the schemes to clarify gaps in coverage of each, to identify categories that stand up to the idiosyncrasies of authorship (for example, "power"), and to create a basis for relating the considerable psychological research behind Schwartz's values to the more policy-relevant values constructed by Lasswell.

In defining values we do not assume that this psychological construct is real, in the sense of existing independent of human subjectivity and awaiting discovery by some enterprising researcher. Psychological theoreticians continue to produce schemes and related metrics to slice and dice the continuum of affective and cognitive human experience, with the hope that it will constitute progress toward greater efficiency of communication and efficacy in application. Most psychological schemes reflect human experience, yet some do so more consistently in certain contexts and offer better prospects for a more or less stable language. We do not conclude from this that such schemes are "true," only more efficient, concise, or perhaps politically privileged within academia. Given our relativist's perspective on the human psyche, we also recognize that notions of values are partly defined by the surrounding field of concepts, all of which seem to be in continuous flux as academicians seek to expand or restrict scope in pursuit of purity or even professional advantage. Conceptions of values overlap with conceptions of traits, attitudes, preferences and worldviews, which require that we offer at least some semblance of definition for all.

2 A Definition of Values

"Values," as a term, has been used to refer to everything from storylines to objects. We find it most useful to apply the term to the fundamental non-linguistic ways that people orient to the world. According to this notion, values are physical and psychological indulgences that people desire or seek. For most people, desire is accompanied by an ethical or moral justification or simply a self-adequate explanation for why the desiring is desirable, with predictable self-reinforcing tendencies. Most existing definitions of values emphasize an ethical element (Hitlin and Piliavin 2004), but the policy-relevant notions discussed here are, in application, clearly rooted in the preceding desire or attraction.

For purposes of understanding human behavior in policy systems, values are also best conceived of as enduring general tendencies as opposed to transitory and context specific. Knowing, for example, that someone has a persistent attraction to power, as a value, offers greater opportunity for insight into policy-related behavior compared to knowing that someone has an evening's attraction to snowmobiling. References are frequently made to people valuing things, such as timber, grazing, or roads. We find it more useful to construe values as comparatively few abiding foundational orientations. In other words, valuation can be understood at three resolutions: (1) specific to singular things or experiences, such as a wilderness outing at a particular time and place; (2) specific to cultures, societies, or technologies, such as wilderness or off-road vehicular recreation; and (3) broadly applicable to the human condition, regardless of time, place, or culture, which is the conception we offer here.

2.1 Schwartz's Schematic

Of the numerous schemes to classify values or related notions functionally, Shalom Schwartz's categories (Schwartz and Bilsky 1987, 1990) are perhaps the most widely accepted in circles of psychological research. The classification consists of ten parts: power, achievement, security, tradition, conformity, benevolence, universalism, self-direction, stimulation, and hedonism. Schwartz and others hold that this classification efficiently, comprehensively, and functionally captures what people value in life, transcending specific situations (Schwartz 1992, 1994; Spini 2003).

Because of its roots in psychodynamics, this classification lends itself to consolidation under the superordinate categories of self-enhancement (the first two), conservation or conservatism (the second three), self-transcendence (the next two), and openness to change (the next to last two). Hedonism straddles self-enhancement and openness to change. In other words, people who strongly orient toward power and achievement tend to behave in self-enhancing ways, those who orient toward benevolence and universalism behave in self-transcending ways, those who orient toward self-direction and stimulation behave in ways open to novel or challenging

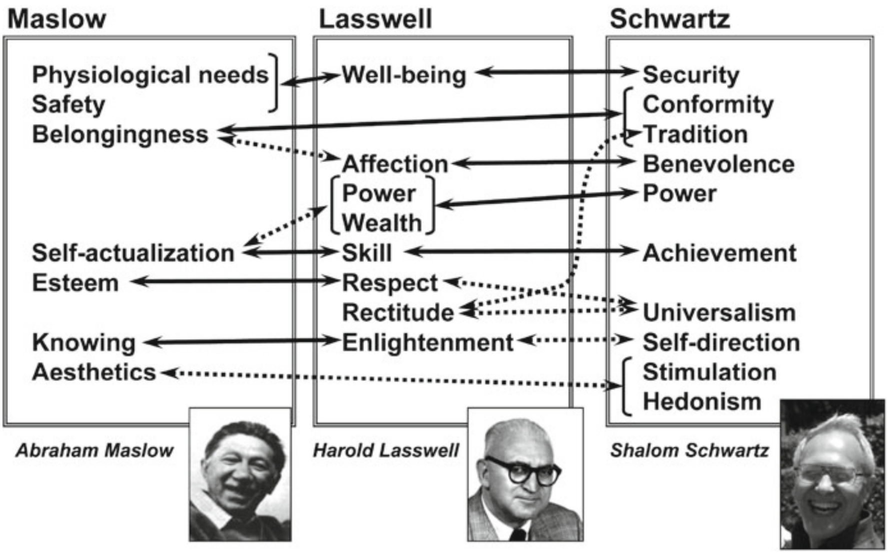

Fig. 12.1 Relations (*arrows*) among Lasswell's, Schwartz's, and Maslow's classifications of values or "needs." *Dashed arrows* denote conceptually weaker relations

experiences, and those who orient toward security, tradition, and conformity behave in ways that preserve the status quo – all with obvious implications to how human interactions might unfold.

2.2 *Lasswell's Schematic*

Harold Lasswell introduced a value classification in 1948 explicitly designed to link individual orientations with societal institutions (Lasswell 1948; Lasswell and Holmberg 1992). This eight-part scheme consists of power, wealth, skill, well-being, rectitude, respect, affection, and enlightenment. Lasswell's scheme clearly relates to Schwartz's, although Schwartz explicitly subsumes wealth under power, as a form of control, and includes the values of hedonism and stimulation, which are only obscurely suggested by Lasswell's classification (Fig. 12.1). One of the most important contributions of Lasswell's scheme is the linkage between values and institutions (Clark 2002; Lasswell 1971). For example, wealth pertains to institutions of finance, power to institutions of politics, and enlightenment to institutions of education.

This linkage to institutions is fundamental to Lasswell's classic formulation of the policy process: people seeking values through institutions using resources (Lasswell and Kaplan 1950). Lasswell and his collaborator Myers McDougal did not claim that each value was unique to each institution (Lasswell and McDougal

1992a); they merely claimed that one value tended to be featured, with all other values at play in some measure for the involved people. In this context Lasswell made a key distinction between scope or terminal values (values that were ultimately being sought) and base or instrumental values (values being used to obtain scope values). All values could be either scope or base, depending on the situation and individuals. For example, wealth (as a base value) is often used within educational institutions to obtain opportunities for enlightenment (a scope value). Conversely, enlightenment (as a base value) is often used in financial institutions to obtain more wealth (a scope value).

2.3 Maslow's Hierarchy

Maslow introduced an influential theory in 1943 positing that humans experience a hierarchy of "needs," from maintaining adequate physiological function and obtaining security, affection, and esteem to acquiring knowledge and experiencing beauty to self-actualization and transcendence (Maslow 1943, 1954). These needs correlate with the values of Lasswell and Schwartz (Fig. 12.1), consistent with both needs and values motivating people to seek something from the world. The merits of Maslow's theory have been vigorously debated, though usually without calling into question the notion of some kind of hierarchy. Disagreement has often centered on refining the hierarchy, the nature of "need," and whether "need" is defined by the immediate subjective perceptions of individuals or by more stable trans-subjective considerations related to survival, individual development, and attainment of human dignity (e.g., Wabba and Bridwell 1976; Sirgy 1986; Zinam 1989; Heylighen 1992; Diener and Diener 1995; Frame 1996; Pyszczynski et al. 1997; Hagerty 1999; Sheldon et al. 2001; Harper et al. 2003; Oleson 2004).

We find a trans-subjective conception useful for application to policy given the self-evident importance of death or chronic illness if physiological functions cease or are compromised and the profound psychological impairment that occurs when people are deprived of physical contact and affection (e.g., Woolverton et al. 1989; Goldfarb 1945; Hollenbeck et al. 1980; Kagan and Moss 1983; Haney 2003; Maercker and Schützwhal 1997; Van der Kolk 1987). This perspective is also consistent with the widespread correlation between wealth and well-being. People's subjective assessments of their well-being are strongly linked to income and its associated baseline physical provisions, but only up to a point, after which well-being is uncoupled from wealth (Diener and Oishi 2000; Veenhoven 2000). All of this research is consistent with some sort of hierarchy in factors affecting the human condition.

Viewed this way, Maslow's hierarchy of needs complements the values of Lasswell and Schwartz by implying a policy-relevant ranking of needs related to physical survival, self-enhancement, and self-transcendence. Individual histories, codified in personality, combine with circumstance to determine whether people are captive to survival values or free to seek transcendence, with effects on how they treat each other in matters related to natural resources. Similarly, if human dignity is the guide (see below), then physical survival logically trumps rectitude when such fundamentally different stakes are at odds in a decision that is part of a policy process.

We are not saying that self-transcendent values cannot be powerful motivators for certain people at certain times – to the point, for example, of driving some to risk or even seek death in a righteous cause. Rather, we are suggesting that the notion of hierarchy can be useful to understanding differences between classes of natural resource policy cases, for example, involving air and water pollution (more relevant to physiological function and health) versus endangered species (more relevant to rectitude or self-transcendent appeals), rooted in psychological dynamics intrinsic to the very construction of consciousness.

3 Values Versus Preferences, Attitudes, and Traits

Values, as we construct them here, differ from preferences, attitudes, and personality traits. Although clearly influenced by values, preferences are defined with explicit reference to external conditions in a specific context – technically the rank order of choices that a person would make given equal access to a fixed set of options, whether durable or experiential (Samuelson 1948; Sen 1973). Would a person preferentially choose a wilderness hike or a day at the movies, given no difference in cost? Rank order and limited explicit options are central to the notion of preference, but not to values.

Attitudes also embody values, but as with preferences they are directed toward specific objects, experiences, or alternatives, with an assessment of good, bad or indifferent (Chaiken and Stangor 1987; Kraus 1995; Petty et al. 1997; Vaske and Donnelly 1999; Hitlin and Piliavin 2004; Dietz et al. 2005). By their nature, attitudes are well-suited to measurement on a scale ranging from like to ambivalent to dislike. Unlike functional values, attitudes are as numerous as the objects and experiences that people or analysts choose to differentiate, and they are distinguished by a judgmental stance regarding the outside world rather than by an inward-originating desire.

In contrast to preferences and attitudes, which integrate and embody values, personality traits are more deeply psychologically rooted, impulsive ways of being. The best-known contemporary scheme for describing traits is commonly known as the Big Five: extroversion, conscientiousness, agreeableness, openness to experience, and neuroticism (Digman 1990; Goldberg 1990; McCrae and John 1992; McCrae and Costa 1996; O'Conner 2002). Each of these traits is expressed to varying degrees largely configured by genetics and early developmental experiences (McCrae et al. 2001; Lang et al. 2002). As such, traits more plausibly affect value orientations rather than the reverse, and, in fact, researchers have found positive associations between Big Five traits and Schwartz's values: of extroversion with power and stimulation, conscientiousness with achievement and conformity, agreeableness with benevolence, tradition, and conformity, and openness with universalism and self-direction (Bilsky and Schwartz 1994; Dollinger et al. 1996; McCrae 1996; Roccas et al. 2002; Olver and Mooradian 2003; Aluja and García 2004;

Van Hiel and Mervielde 2004; Cohrs et al. 2005). Neuroticism has no strong association with values and can be thought of as an expression of unsuccessful strategies for coping with existential concerns.

4 Values Versus Worldviews

Values, as we have defined them, are also conceptually different from worldviews or, more specifically, views of nature. Worldviews are perhaps best understood as symbolically resonant narratives that embody values and encompass and articulate beliefs about how the world is and should be (Damasio 1994, 1999; McAdams 1996; Deacon 1997; Tomasello 1999; Donald 2001; Fauconnier and Turner 2002; Koltko-Rivera 2004).

Scholars have offered numerous ways to classify views of nature, typically arrayed along a gradient from the anthropocentric to eco- or biocentric, at one extreme averring the centrality of humans and instrumental "valuation" to, at the other extreme, asserting the intrinsic worth of nature (Gagnon Thompson and Barton 1994; Stern and Dietz 1994; Fulton et al. 1996; Karp 1996; Vaske and Donnelly 1999; Deruiter and Donnelly 2002; Dietz et al. 2005). Stephen Kellert developed perhaps the most nuanced scheme for describing the ways people understand and give voice to relations between people and nature, which he has at times termed "attitudes" (Kellert 1985, 1989, 1996; Kellert and Smith 2000). At the most anthropocentric, nature is feared or viewed as something to dominate and convert into wealth (i.e., the negativistic, dominionistic, and utilitarian views). At the most biocentric, animals have standing as virtual people, humans carry a burden of stewardship, and nature is prized primarily for its beauty and healing presence (i.e., humanistic, moralistic, aesthetic, and naturalistic views).

Values and nature views are not synonymous. People can hold a range of both. For example, two people could prioritize power, yet one voice a dominionistic perspective and the other one a moralistic perspective – both seeking power, but to advance different animal- or nature-related outcomes. Yet values and nature views are not entirely independent. Those who prioritize self-enhancement and conservatism do tend to hold anthropocentric nature views; those who prioritize self-transcendence and openness to change tend to hold biocentric nature views (Stern and Dietz 1994; Kaltenborn et al. 1998; Vittersø et al. 1998; Bjerke and Kaltenborn 1999; Schultz and Zelezny 1999; Clump et al. 2002; Kaltenborn and Bjerke 2002; Schultz et al. 2005).

5 Values and Behavior

Values are also clearly not divorced from how people tend to treat each other and whether their interactions cumulatively erode or enhance collective dignity. Universalism and, less so, self-direction positively correlate with both human-centered and nature-centered altruism as well as with the capacity for empathy and the taking of others' perspectives (Schultz 2000, 2001). It is thus not surprising that universalism positively correlates with both an interest in and capacity to engage with others who have different interests and identities. By contrast, conservative values are positively correlated with maintenance of rigid group boundaries, a disinterest in constructively engaging with unlike others, and a tolerance or even desire for authoritative structure; an emphasis on power positively correlates with egoistic motivations and a willingness to perpetuate inequality among people and groups (e.g., Bilsky and Schwartz 1994; Sagiv and Schwartz 1995; Sullivan and Transue 1999; Whitley 1999; Heaven and Bucci 2001; Heaven and Connors 2001; Roccas et al. 2002; Jost et al. 2003; Aluja and García 2004; Ekehammar et al. 2004; Van Hiel and Mervielde 2004; Cohrs et al. 2005; McFarland and Mathews 2005a, b; Duckitt 2006). The bottom line is that a greater capacity for self-transcendence and self-direction increases the odds that conflicted participants in natural resource cases will be able to engage civilly to find common ground, in contrast to situations where circumstances and personalities lead participants to focus on self-enhancement and conservatism.

6 Values and Human Dignity

Building on such relations, Harold Lasswell and Myers McDougal crafted operational definitions of human dignity and democratic character expressed in terms of functional values (Lasswell 1948; McDougal et al. 1980; Lasswell and McDougal 1992b). Dignity is a condition that arises when humans have sufficient access to all values (Fig. 12.2). In application, sufficiency is inexact; as a notion, however, this definition of dignity is a powerful heuristic tool. We may not know exactly when human dignity has been achieved, but, at the same time, it is not too difficult to recognize when individuals have been so deprived of access to power, or wealth, or well-being (e.g., health), or respect, or enlightenment (e.g., education), that their dignity has indeed been impaired. Likewise, "democratic character" does not lend itself to definitional closure. Yet, people who orient strongly toward respect, universalism, enlightenment, or self-direction more dependably exhibit democratic character compared to those who have no concern for others and are consumed by the pursuit of wealth, power, or personal achievement. Liberal democracies depend for their survival on values such as universalism or enlightenment that are manifest in informed, civic-minded citizens who respect the rights and interests of others (Madison 1961; Schattschneider 1975; Dahl 1982, 2006; Shils 1997). Such values socialize citizens to limit conflict and bear the losses that are an inevitable outcome of democracy in action.

7 Values Versus Interests

Most observers of political behavior describe human motivations in terms of interests (e.g., Susskind and Cruikshank 1987). People self-evidently pursue their interests through societal institutions, using whatever strategies and resources they

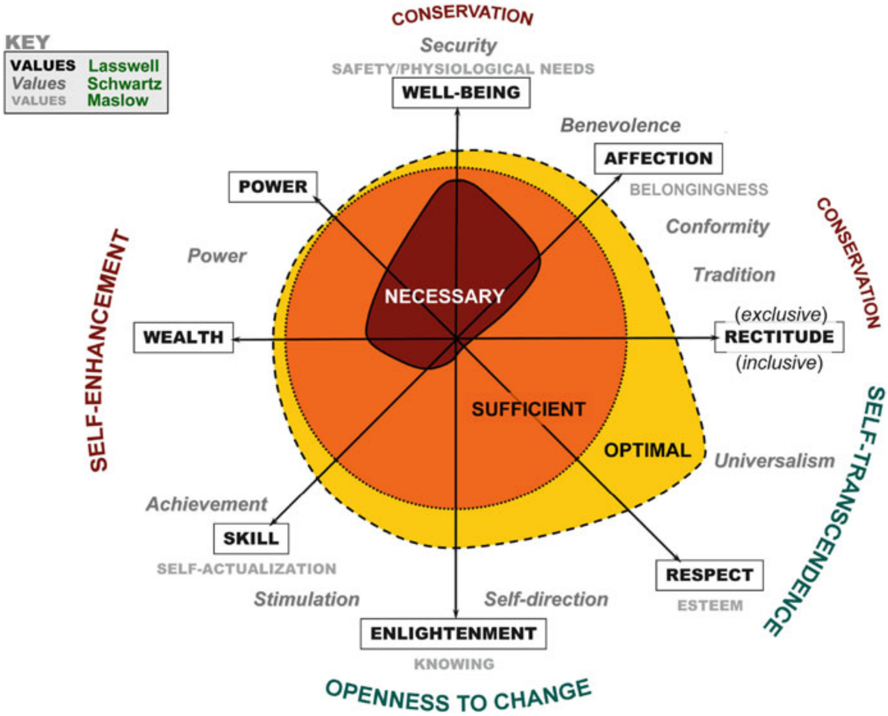

Fig. 12.2 A diagrammatic heuristic showing relations between Lasswell's, Schwartz's, and Maslow's classifications of values or "needs," distributed as necessary to sustain autonomous life function over nominal periods of time ("***NECESSARY***"), sufficient to achieve minimum human dignity ("***SUFFICIENT***"), and optimally expressed in democratic character ("***OPTIMAL***"). Values can be notionally plotted on this diagram to express both the aspirations of individuals and the outcomes or effects of situations

have at their disposal or are inclined to use. Strategies for advancing interests range from the more ameliorative, in the form of negotiation, to the more punitive, in the form of forceful imposition. Interests are an understandable focus of attention for those who observe the superficial dynamics of socio-political processes, because people typically express their demands that way. Interests are explicitly attached to desired time- and place-specific outcomes, which are articulated in the form of narratives that people construct for themselves and others. Put more esoterically, McDougal et al. (1980) defined interests as "a pattern of demands for values plus the supporting expectations about the conditions under which these demands can be fulfilled."

Notice that McDougal and others explicitly relate interests to values as well as to context. Viewed this way, interests can be understood as context-specific expressions of value orientations or value demands. People's demands are typically in the form of some concrete thing or experience, but in virtually all cases functional values can be divined just below the surface. In some cases the link is overt, as when people expressly seek power or money or skill or love or loyalty, but more often the value – in the sense of Schwartz or Lasswell – is implicit rather than explicit.

An exclusive focus on interests can handicap those who are engaged in analyzing human dynamics or in designing and implementing decision-making processes, especially if the goal is to change the dynamics to achieve different outcomes and effects. The rhetoric of expressed interests is often politicized, in that it is framed to gain advantage and enmeshed in the drama of most policy processes. Interests are also often focused on the content and outcomes of decision making rather than the nature and quality of the processes themselves. A focus on content is problematic because process is at the heart of societal institutions, and it is through the processes we design and perpetuate that we either achieve a commonwealth of human dignity or spiral into a quagmire of despotism. A focus on value demands, value creation, and value exchanges opens a window on dynamics that we contend are the most meaningful when it comes to diagnosis and design.

8 Values in Researching and Understanding Policy Processes

As conceptualized here, values are central to human social interactions and decision making. At the most basic level, human interactions can be understood as the creation and exchange of values. Likewise, decision making can be thought of as the allocation or appropriation of values, and policy making as the process of how and under what circumstances society will make values available to whom. Lasswell's analytic framework, featuring standpoint clarification, problem orientation, and social- and decision-process mapping (Lasswell 1971; Lasswell and McDougal 1992a; Clark 2002), is especially well-suited to this conceptualization of values as central to human affairs. According to Lasswell, assessment of participants' value priorities, value demands, value deployments, and value gains or losses is central to researching and understanding policy processes, framed as social interactions organized around decision making. What values are at stake, for whom, with what salience, in what decisions, and with what immediate and longer-term value outcomes?

Scale is critical to analyzing value dynamics in policy or decision-making processes. Values are at stake for people at three plausible scales (Fig. 12.3): in the decision-making process itself, as a direct outcome of the process, and as longer-term effects of ingrained patterns. Power and respect are often paramount values at stake for individuals in the design and execution of authoritative decision making; affection and enlightenment can also be major values at play. In other words, who has a seat at the table (power) with what kind of authority and accountability (power), and are those involved inclined to accommodate the interests of others (respect) and treat them civilly (respect) as a basis for reaching durable outcomes? Are those involved capable of empathy for others (affection/benevolence), do they have loyalty to the group and its process (also affection), and do they seek information

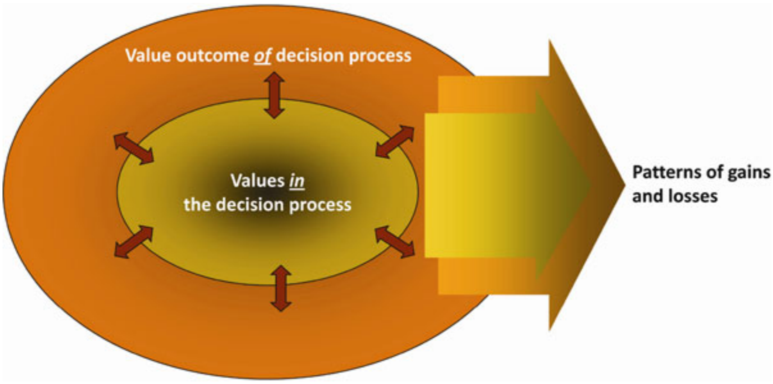

Fig. 12.3 A conceptual representation of relations among value dynamics at three scales: *in* the decision process; as an immediate outcome *of* the decision process; and as longer-term broader-scale effects of value gains and losses

as a way of building shared understandings of how the world works (enlightenment), as a basis for solving collective problems? All values can be at stake in outcomes of authoritative decision-making, but in most societies wealth, well-being, and rectitude (morally correct outcomes) are often priorities. In the longer term, value dynamics that indulge the few at the expense of the many can erode the very bases for civil society and human dignity.

We have found that clarifying scale-specific value dynamics provides powerful insights, especially when coupled not only with worldviews but also with notions of existential psychology. Existential psychologists contend that people are beset with certain core concerns that arise from the very nature of human consciousness: concerns about isolation, about meaning, about responsibility, and about death, the granddaddy of them all (Yalom 1980). Existentialists would argue that much of what people do pertains to the resolution of these concerns, and that anxiety and even terror attend any degree of irresolution. From another perspective, people can be viewed as seeking values to address existential concerns or needs. Achieving desired values helps to calm the existential waters, so to speak, whereas deprivation of desired values inflames existential concerns. Psychological researchers have found that anger, frustration, and other expressions of discontent are rooted in underlying fears and anxieties (Ortony et al. 1988; Berkowitz 1999; Strasser 1999), which are rooted, in turn, in existential psychodynamics (Yalom 1980). Building on these concepts, we view anger and frustration as key diagnostics of inflamed existential concerns arising from value deprivations, which are often meted out by poorly designed or implemented decision-making processes. Discontent is the diagnostic, values are the medium, but social and political processes are the ultimate focus.

9 A sample Application: The Glen Canyon Dam Adaptive Management Program

In this penultimate section we apply a value perspective to the analysis of a particularly interesting natural resource management case: the Glen Canyon Dam Adaptive Management Program (AMP). Given the context and space, we are necessarily cursory. Our intent is to provide just enough detail to illustrate the application and potential of a value-based analysis. With that purpose in mind, we explicitly build on several recent substantive appraisals of this program by Camacho (2008) and Susskind et al. (2010). Much of what we present is merely a recasting of these prior analyses in terms of values, but we also build on this previous work to illustrate additional key dynamics thrown into relief by a value-based perspective.

The Glen Canyon Dam was constructed across the Colorado River near the U.S. Arizona-Utah border to control water and provide hydroelectric power. Closure of the dam in 1963 resulted in downstream effects on an ecologically, culturally, and aesthetically important region. These effects precipitated private and public reactions, including application of the U.S. Endangered Species Act to conserve several fish species threatened by dam-related changes in hydrology.

The U.S. Department of the Interior convened a stakeholder group with an adaptive management mandate (the Adaptive Management Working Group, or AMWG) to investigate alternatives for dam management that fulfilled existing legal mandates (for water allocations and energy production) while mitigating negative impacts on downstream resources. The AMWG was constituted as an advisory group chaired by a designee of the U.S. Secretary of Interior, advised by a Technical Working Group, and informed by a science arm called the Grand Canyon Monitoring and Research Center. The AMWG consists of 25 stakeholders representing different interests (Fig. 12.4), but chosen through an opaque process (Susskind et al. 2010). Six stakeholders represent Native American tribes with histories and cultural perspectives quite different from those of others on the AMWG. The Glen Canyon Dam AMP (AMP hereafter) has been represented both as a great success and as a significant failure, although almost all who have been involved privately express considerable discontent.

9.1 Existing Critiques

Camacho (2008) and Susskind et al. (2010) concluded that the AMP suffered from numerous critical failings when compared against ideals of the public trust and collaborative adaptive management. These failings can be identified in both the initial design and subsequent implementation of the AMP. Most pertain to design (i.e., "constitutive" elements), including the poor up-front analysis of interests, an unbalanced representation of interests, the compounding effects of decision-making protocols (e.g., allowance for resolution by vote versus by consensus), the failure to

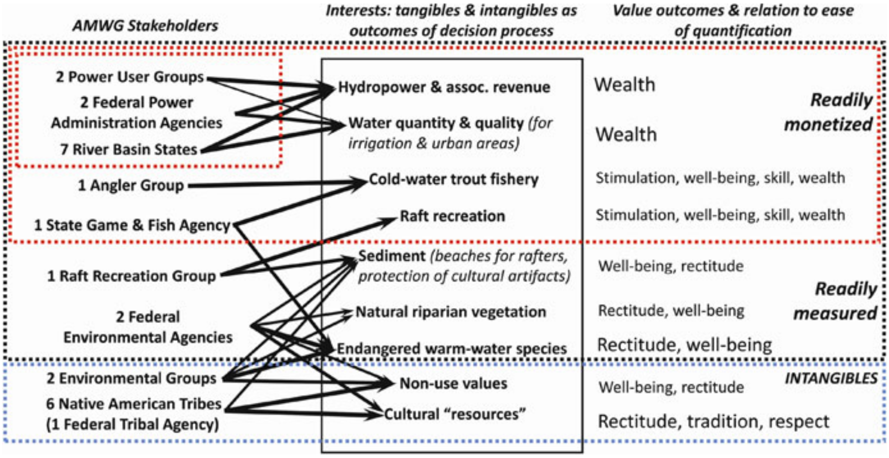

Fig. 12.4 Relations among stakeholder groups, interests, and value outcomes for the Glen Canyon Dam Adaptive Management Program, Adaptive Management Working Group (AMWG). Stakeholders are comprised of groups with a similar focus (e.g., "*Environmental Groups*"), and the number of each is given at the far left. Arrows show how stakeholder groups roughly identify with different interests. The *red dashed box* in the *upper left* identifies groups identified with hydropower and water provisioning who consistently vote as a unified block; all other groups are comparatively fragmented. Interests and values are differentiated by whether they are readily monetized and measured, readily measured but not monetized, and "*intangibles*" not amenable to either measuring or monetizing

involve stakeholders in the design of the process, the failure to clarify the roles and responsibilities at all scales, the failure to clarify the direction and goals of the program, the failure of Congress to fulfill its responsibilities to national-level interests and policies, and the failure to employ joint fact finding in information and science activities. Of relevance more to implementation, the shortcomings included the failure to use neutral facilitators with adequate skills, the failure to secure authoritative agreements with the stakeholders, the failure to build the capacity of the AMWG, the failure to monitor and adapt the decision-making process itself, and the lack of AMWG accountability.

9.2 An Interpretation Based on Values

The value dynamics evident in this case are intriguing. A close reading of Susskind et al. (2010) shows that these authors implicitly or explicitly referenced all of Lasswell's values with rank-order frequency as follows: power (24 instances); respect (20); enlightenment (11); wealth (11); well-being (10); skill (7); rectitude (6); and affection (understood as loyalty; 5). Of greater interest, power and respect were most frequently invoked (21 and 18 instances) in reference to values at stake *in* the AMP decision process, followed by enlightenment and skill (11 and 7 instances). Wealth (11 references), well-being (also reckoned as stimulation; 10), and rectitude (especially relative to cultural values, which include biodiversity conservation; 6) were most frequently mentioned as important value outcomes *of* the AMP decision process. Notice the lack of overlap between priority values at stake *in* the decision process versus as an outcome *of* the process.

Power and respect emerge as seminal values in design and execution of the AMP decision process itself. Power, when broken into its constituent elements of authority, control, responsibility, and accountability, was a priority value pertaining to who participated, representing what interests, with what responsibility, and what accountability. Ambiguities regarding authority and accountability were clearly a major issue, along with imbalances of power in representation, amplified by decision-making protocols. But respect was also clearly a priority value *in* the process. Its relevance was tacit in the way that Susskind et al. (2010) invoked the importance of "collaboration," "constructive engagement," "trust," "having a say," and so on, all of which are rooted in the dynamics organized around respect or its opposite, disrespect (or respect deprivation). Skill was invoked primarily in reference to power and respect, specifically the skill of facilitators in redressing power imbalances and creating a respectful process. Interestingly, although enlightenment (e.g., "learning" and "understanding") was also invoked, this value was not central, which is at variance with tenets of scientific management.

Turning to the value outcomes served by the AMP decision process, it is necessary to relate values to interests to stakeholders to voting patterns (Fig. 12.4). Representatives of the electric power user groups, the river basin states, and the federal power administration agencies routinely voted as a unified block of 11, organized solidly around their interests in hydropower, water for irrigation and urban areas, and associated revenues (Camacho 2008; Susskind et al. 2010). The links between these interests and wealth outcomes were strong. By contrast, the stakeholders aligned with all other interests were fragmented, and the values attached to their interests were diverse and not often directly linked to the attainment of power or wealth. Priority outcomes for those not aligned with hydropower and water provisioning included well-being, stimulation, skill, rectitude, tradition, and respect. Bringing in an additional consideration, all of the interests except "non-use values" and "cultural resources" were easily *measured*, and hydropower, water provisioning, cold-water trout fishery, and raft recreation interests were also easily *monetized*.

9.3 Some Implications

Our very cursory diagnosis, building on Camacho (2008) and Susskind et al. (2010), makes clear that those who constituted the AMP did not deal adequately with the design of elements pertaining to power and respect, either *in* the process or as an outcome *of* the process. This conclusion holds whether we reference public interest, collaboration, or human dignity goals. The AMP appears to have been fraught with power imbalances and ambiguities related to who held authority and who was accountable (Emerson 2010). Equally important was the neglect of respect in all aspects of design and execution, especially early on in the AMP's history. Power imbalance and respect deprivation tend to feed on each other in a way that is particularly insidious. Disrespect often fosters crass uses of power, and vice-versa.

The lack of dignity-informed attention to power and respect issues in the AMP can be plausibly traced back to shortcomings in the paradigm of scientific management. Despite efforts to include considerations of governance (Shindler and Cheek 1999; Olsson et al. 2004), adaptive management remains focused on the process and production of science (Brunner and Steelman 2005). People often assume that enlightenment is paramount in human affairs, especially enlightenment generated by science and especially in the implementation of policy. The AMP – just one case among many – makes it clear that other values such as power and respect are in fact paramount *in* the process of decision making and that enlightenment (as a base value or value resource) is often subordinated to the service of these and other values both *in* the process of decision making and as an outcome *of* decision making. We contend that the model of scientific management perpetuates inattention to critical matters regarding values in the design and execution of policy processes, which, ironically, leads to the heightened politicization of science itself, as described for the AMP by Susskind et al. (2010). Joint fact finding, which Susskind and others recommend, is, as it should be, less about enlightenment than it is about power and respect. Joint fact finding deals with these values in ways that increase the odds that enlightenment will lead to a shared understanding of the world as a basis, in turn, for the creative invention of alternatives and the civil negotiation of interests.

We suspect that interests organized around power and wealth values strongly influenced both the initial design and the subsequent outcomes of the AMP. Those who were oriented toward power and wealth outcomes linked to hydropower and water provisioning were disproportionately afforded power in the design of the AMWG, and they leveraged this power to their advantage by voting and otherwise working as a disciplined block (Camacho 2008; Susskind et al. 2010). The stakeholders who were overtly linked to power and wealth outcomes had an additional *prima facie* advantage because their interests were not only easily measured, but also easily monetized, which conforms not only to the cultural and societal biases of the United States but also to the predispositions of biophysical science: if you can't measure it, it doesn't really matter. The AMP materials that document how the trade-offs were evaluated (http://www.usbr.gov/uc/envdocs/) show that monetary impacts on hydropower interests were often calculated with great exactness.

The advantaged position of the stakeholders with hydropower and water interests contrasts sharply with the position of those stakeholders whose interests were not amenable to either measurement or monetization, or not as easily linked to power and wealth outcomes. Virtually all of these disadvantaged stakeholders were tribal representatives who, in part, expressed interests related to wealth (e.g., economic development), but more often expressed interests related to rectitude and tradition (e.g., sacred or spiritual interests attached to the symbolic construction of places and practices), with little overt connection to science and monitoring activities that are supposedly at the heart of adaptive management (Dongoske et al. 2010). Based solely on the observed dynamics of the AMWG (e.g., Emerson 2010), we speculate that tribal representatives experienced chronic respect deprivation in a process that marginalized their interests, as if by design. This speculation is consistent with the first author's observations of public statements by tribal representatives, which evinced feelings of disrespect and highlighted the alien nature of science-based management. By focusing on the authority of science and scientists and the related assumed primacy of enlightenment, the AMP, as a special case of adaptive management, seems to have chronically disregarded respect dynamics and perpetuated outcomes that were corrosive to civility and human dignity.

Observations by Camacho (2008) and Susskind et al. (2010) as well as our own observations establish that most people involved in the AMP are discontented. As we noted earlier, discontent is often a sign of chronic value deprivations. The most significant deprivations apparently have been of power and respect *in* the process, especially for those whose interests were not organized around hydropower and water provisioning. Virtually everyone who expresses themselves about the AMP tacitly or explicitly communicates feeling disrespected. Such violations of "self" typically lead people to hunker down around their special interests, a defensive closure rooted in fear and distrust. Under such circumstances, invocations of the greater good are treated with skepticism at best, which confounds any realization of common interests. Moreover, politicization of science is almost inevitable, and enlightenment becomes a base value deployed in service of partisan interests, which is the very antithesis of the presumed intent of collaborative adaptive management (Susskind et al. 2010).

10 Conclusion

We find that the functional notion of values described here offers considerable insight into people and their interactions in natural resource cases. As with all concepts, classifications of values are rubrics, with the associated risks of over simplification, but also with the virtue of offering a manageable language for analysis and communication. Individuals' value orientations are also not static. They vary with age and circumstance, which means that any value-based understanding of human behavior cannot be divorced from an understanding of context. People do seek "things," but we suggest that, more fundamentally, they seek to shape and share values with others through exchanges structured by the norms of societal institutions (Lasswell and Holmberg 1992).

In a commonwealth of human dignity, values are widely shared and enjoyed (Mattson and Clark 2011). Under despotism, the privileged few accumulate values by depriving the disadvantaged many. Tensions between despotic and democratic forces occur not only within states. They also occur within our institutions of natural resource management, often in ways made opaque to those involved by the normalizing effects of bureaucratic routine. Scholars of democracy have repeatedly suggested that a principal duty of democratic citizens is to identify and to nullify those forces that produce despotic outcomes. The concept of values presented here potentially offers such agents of democracy a compass that is oriented to the concept of human dignity.

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Chapter 13
Flow in the Everglades

Stephen S. Light and Jan Adamowski

Keywords Everglades restoration • Policy design • Evolution • Experimental designs • Powers of dominion and relationship • Water institutions • Decompartmentalization • Personal knowledge • Science and sensibilities • Reasoning for complex problem solving • Prosilience

1 Prologue: Commentary as Personal Knowledge

Much has been written about the Everglades[1] over the years but little analysis of "the game within the game" has been provided – what we don't see or don't want to even hear about. We seldom learn about how the Everglades Restoration or most other human endeavors of sizeable consequence have been managed, or mismanaged. Once a policy decision is made, we tend to move on to the next issue or problem even if the policy is proven to have failed.

This analysis and commentary are drawn from personal knowledge of and direct involvement of the first author in the Everglades at the policy level from 1979 to 1994 and 2003–2006. This timeframe witnessed the restoration come to bud in federal legislation that initiated a re-study (1994) of the Central and Southern Florida Flood Control Project, resulting in the Comprehensive Everglades Restoration Plan (CERP) (2000). After a 10-year hiatus, the first author returned to assist staff with

[1] For an overview of the Everglades the reader is referred to http://en.wikipedia.org/wiki/Everglades

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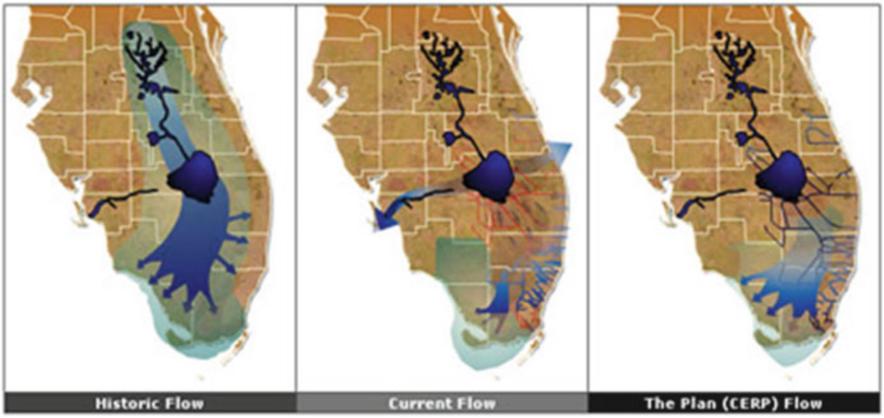

Fig. 13.1 Jacksonville District Corps of Engineers conceptual renderings of historic flow, current flow and the Comprehensive Everglades Restoration Plan anticipated rerouting of flows

the challenges of CERP implementation from 2003 through 2006.[2] The promise in the germ of the restoration idea has yet to (and may never) flower (Fig. 13.1).

Material for this chapter about the decompartmentalization project of CERP comes from in-depth research of the Everglades history entwined with interviews with Art Marshall (administrator of Vero Beach Office of the US Fish and Wildlife Service; authored first plan for Everglades restoration, 1970), John DeGrove (Professor, Florida Atlantic University and leader in Florida land and water policy reform), Marjorie Stoneman Douglas (author of *The River Of Grass* 1947; Florida's first lady of Everglades restoration), Nat Reed (held policy maker positions involving Everglades at state and federal level, esteemed member of the South Florida Water Management District (SFWMD), advisor to policy leaders on all matters pertaining to the Everglades), Martha Musgrove (Associated Editor, Miami Herald; founder of national organization for environmental journalists), Timer Powers (secured first ever treaty with Seminole Tribe, involving flowage easements essential for restoration for restoration, board member and executive director of SFWMD, a dear friend of first author who passed away prematurely), Walt Dineen (chief biologist; also a dear friend whose passing was also premature), and the meticulous minutes prepared by Tom Huser (secretary to the SFWMD governing board). Through extensive conversations with Tom Huser, the first author came to appreciate the detailed history of water management in the Everglades; known for his decidedly dispassionate mind of a journalist, with a remarkable gift of a photographic memory, and almost total recall of major events spanning three decades[3] (Light 1983).

[2] The authors make no claim to the procession of events after the DAMP design was approved in April, 2006.

[3] Tom Huser was not given the opportunity to write its 40 year history.

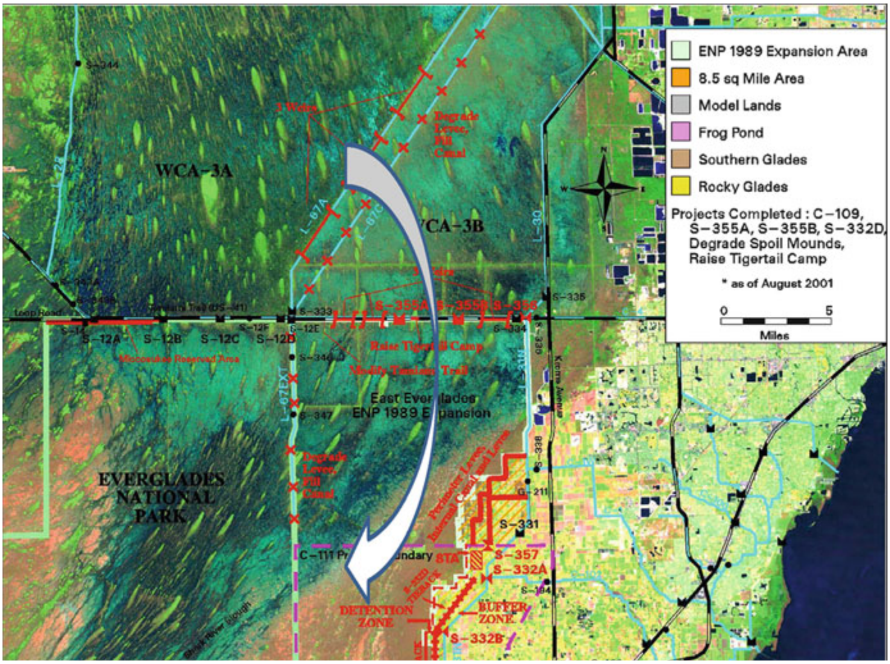

Fig. 13.2 Courtesy Everglades National Park Corps of Engineers project features map with "swoosh" indicating where the introductions of flows into Northeast Shark River Slough were made

The first author's personal policy involvement began in 1983 as chair, with the support of Kathleen Abrams (the board representative from Miami), of the SFWMD Task Force on the South Dade Conflict. Within six months, we resolved the pressing conflict with farmers and landowners (Light and Wodraska 1989) over the introduction of flows into Northeast Shark River Slough, which the tenth Circuit Federal court had enjoined the SFWMD from pursuing (Fig. 13.2).

In addition, the Task Force's actions included a series of experimental flows during the El Niňo event (~1982–1983), including a "flow through" release of maximum discharge through the S-12 structures into the Everglades National Park from Water Conservation Area 3A. These actions broke the political gridlock over the monthly water allocation scheme arbitrated by Stan Caine in 1970, Assistant Secretary for Fish, Wildlife and Parks within the Department of the Interior. It dispelled the myth held by Dade County officials that the waters of Water Conservation area 3A were held in reserve exclusively for their county (Fig. 13.3).[4]

The El Niňo event was also used as a political and legal screen for the Army Corps of Engineers (Corps) to invoke emergency powers that included breaching

[4] The District received a sharp report in letter form, signed by the heads of Dade County Sewer and Water, Planning and Environmental Regulation indicating that such District action in the future would be challenged in court.

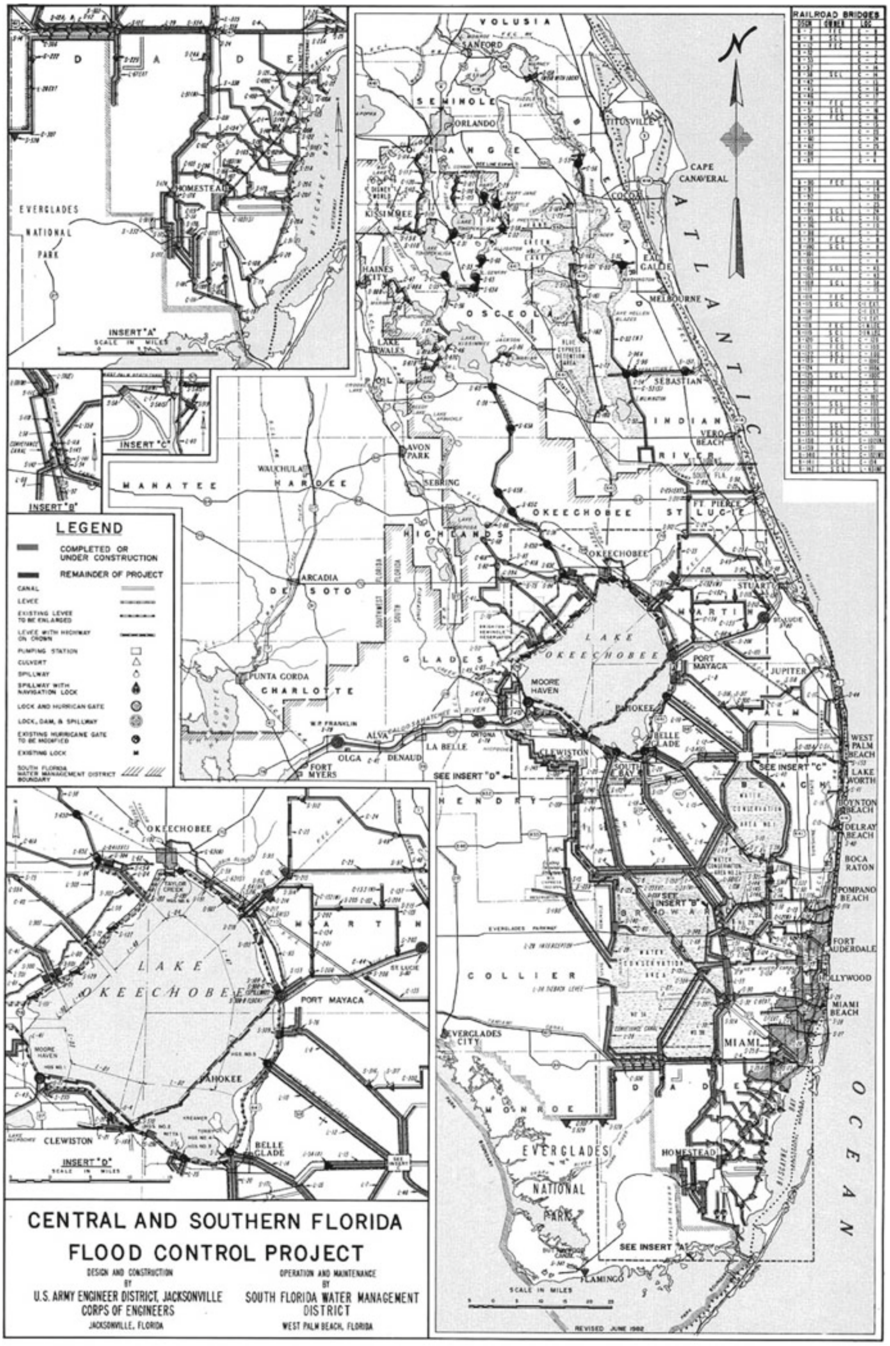

Fig. 13.3 The Central and Southern Flood Control Project (Map Courtesy of the Jacksonville District Corps of Engineers)

the levees in the southwestern corner Water Conservation Area 3A, directing flood flows into the Big Cypress reserve. With the leadership of Representative Dante Fascell, the SFWMD, Corps, and the Everglades National Park received congressional authorization[5] for experimental water deliveries through 1989[6] based on Tom MacVicar's (SFWMD engineer) rainfall-driven model.

In summary, the wake of the El Niño flood cycle provided the opportunity and, indeed, the mandate for a set of natural experiments that changed for a decade the political mind set along the Everglades "no man's land,[7]" the Tamiami Trail.

The preceding paragraphs testify to the intimacy with the subject matter that underpins this chapter. The following account of the Everglades attempts fidelity with one of Michael Polanyi's (1958) signature concepts – "personal knowledge" – which is neither subjective nor burdened by myth of objectivity.

This account is based on personal experience and reflection, including meeting notes, workshop summaries, staff presentations, and gray literature spanning the two decades of direct involvement of the first author, initially as the first SFWMD policy director and subsequently in assisting the inter-agency team that assumed responsibility for implementing adaptive management for CERP.

Consistent with the theme of this book, this chapter logs relationships in paths traveled, actions taken, mistakes made, and lessons learned in the Everglades that support the scaffolding to becoming more future-responsive in our "dialogue with nature" (Prigogine 1997). In constructing this narrative, which sets forth a concept of policy design for evolution (PDE) Jantsch (1980), Jantsch and Waddington (1976), the first author is joined by Jan Adamowski as co-author. Together, the authors draft the means for straddling the crumbling era of control, management and domination by the "Iron Triangle" (i.e., legislators, special interests and agency personnel) with the design of governing integrative water regimes for evolution.

This chapter will reach beyond the project-centric management and control mentality that has failed to deliver the performance, nor build the social and ecological associations or search for excellence, required for ecological restoration. What is not understood is that ecological restoration cannot be conceived as assembling pieces of a jigsaw puzzle. Restoration can only be advanced through the creation of composite solutions that resolve 80–90% of the contentious relational and highly contextual, systems-centric needs. Policy Design for Evolution, an alternative approach to restoration and regime governance, will be discussed in more detail later in the chapter.

[5] Although fully engaged in the resolution of the court injunction and the specifics of our rainfall driven plan for water deliveries into the Park, the Superintendent and the Director of the Park's research station chose not to share the monitoring program they put into place to determine ecological responses.

[6] Approved by the House of Representative Interior Committee chaired by Bruce Vento, who I had the pleasure of discussing our remembrances of those times before his premature death at 52 years of age.

[7] Tamiami Trail is referred to as "no man's land" for the simple fact that there is no governance structure that has ever been designed to unify management of the Everglades from Lake Okeechobee to Florida Bay.

2 The Search for Excellence

We argue that if the quality of life on earth is to attain a level that makes it worthy of our children's children, the potential for the greater good embodied in the practice of relational power as distinct from unilateral power must come to the fore in the governing of relationships in our social and political affairs.

While ***"the issue is in doubt"*** (i.e., the outcome of the human predicament) (Waddington 1977), we point to human nature joining life's struggle toward creative advance in a search for excellence (***prosilience,*** or the emergence of the prospective mind of man in becoming future-responsive) as hope for the future.

We claim that the pursuit of excellence in human relationships with nature must adhere to nature's evolutionary operating rules. This pursuit is in many respects the path of last resort (Light 2001b; Kauffman 1995; Polanyi 1958). Ecological restoration is a process of creative emergence that lies beyond our ability to direct or command. Our greatest fear is that society's quest for certitude and the propensity to resort to the practice of unilateral power will preclude the emergence of the social and ecological relationships appropriate to restoration. Further, scientific knowledge, one pillar of modern creative advance, is in jeopardy of being conscripted in the service of unilateral power – science used at the very least as a screen for the pursuit of policy by other means.

The intent of this chapter is to describe, analyze and comment on the design and development of the large-scale, flow-response experiment located north of Tamiami Trail in Water Conservation Areas A and B and the Shark Slough to the south in the Everglades National Park through to its plan approval by the Quality Review Board, April, 2006. In so doing, the authors critique an oft-prevailing approach to problem solving the rational actor model dominated by reductionism. Empiricism and rationality fall short of providing the tools for reasoning necessary for action as inquiry into an indeterminate reality essential for "becoming with" nature, rather than a presumption of surety. This chapter will rely on a form of what Immanuel Kant referred to as "practical reason;" reason best understood as problem solving. We adopt the term ***'relationality'*** to denote problem solving as "a dialogue with nature" (Prigogine 1997), where the fundamental unit of analysis is relational and not an 'object.'

> *"There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things."*
>
> Niccolo Machiavelli

3 The Limits of Understanding

Empiricism and rationalism in their abstractness and 'objectivity' have failed to deliver consistent authentic insights in our dealings with natural dynamical systems. Relationality as problem solving requires not being separate from but being embedded in the warp and woof of the social-political and ecological fabric. Another turn of the same phrase would be to say – if you are not part of the problem, you cannot be part of the solution. We favor the phrase "the game within the game" to convey the attention that will be paid to contextual awareness as well as the focal attention (Gelwick 1977) needed to get beneath the surface of things; making the invisible, visible in a relational context.

We admit that human understanding of reality never completely shakes off its ambiguity and tentativeness (Alfred North Whitehead 1929). Karl Popper (1989) would concur that our knowledge of reality is proximate, never rising above that of sophisticated conjecture. To paraphrase Kenneth Boulding – really important ideas never arrive unambiguously (Figs. 13.4 and 13.5).

4 Unilateral and Relational Power in Water Resources

The awesome display of relational power in nature arrives as the spontaneous emergence of new life and wellbeing of the other, the "becoming with" (Gilbert and Epel 2009). In contrast to relational power, the human contrivance of rationality exemplified in cost-benefit analysis, based on Bentham's utility theory, reduces the "other" to a statistic, where inequities, predominate and are easily disguised, such as multiplier effects that systematically favor urban over rural water projects.

The continued practice of cost-benefit analysis is barren, place a rational actor template over a highly contextual situation that needs shared understanding by all involved not poorly informed explanations by policy analysts. Bereft of all authenticity, cost-benefit is unworthy of the societal task that confronts us as the human predicament. The following are examples of how unilateral power has been evident in the use of cost-benefit analysis for water resources project evaluations:

The first case involves the Corps of Engineers Principles and Guidelines for water planning. The congressional legislation (Water Resources Planning Act of 1965) authorized the development of principles and standards in evaluating the suitability for 'federal interest' in proposed water projects. Four accounts were established in the legislation to be used in making a determination – Environmental Quality, Social Wellbeing, Regional Economic Development and National Economic Development.

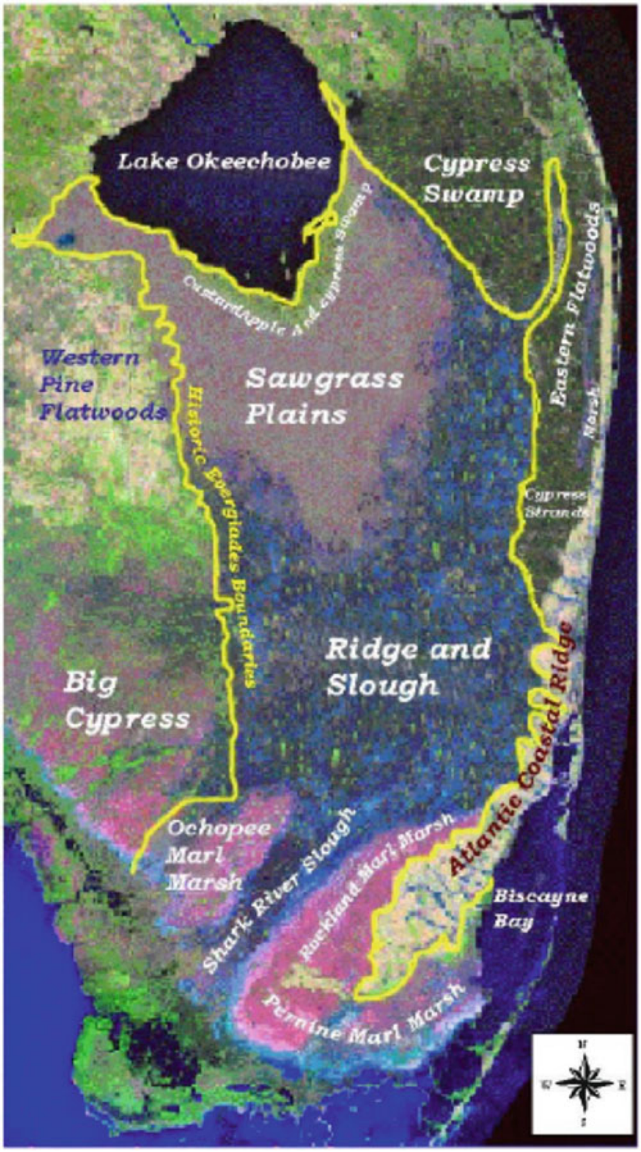

Fig. 13.4 The satellite image above depicts the Everglades before massive alteration for drainage and flood control beginning in 1905. Satellite image of South Florida with major natural systems Greater Everglades identified (Courtesy Everglades National Park)

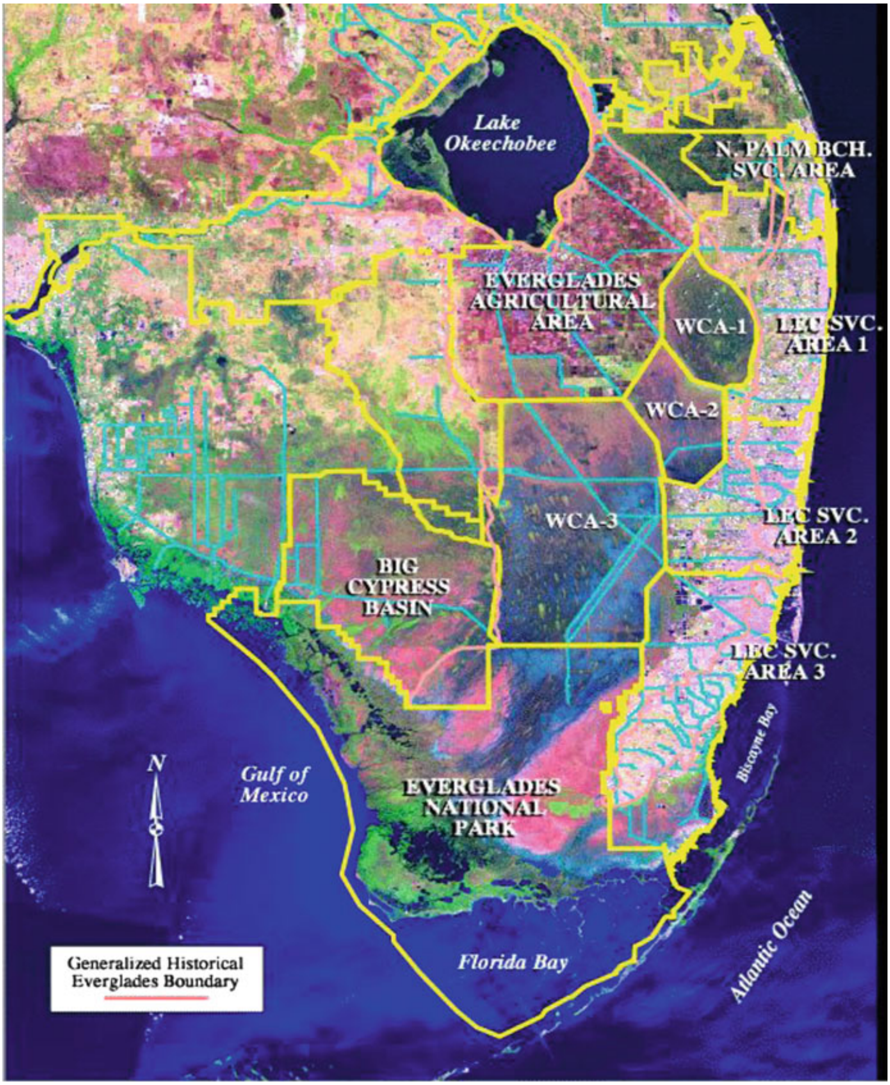

Fig. 13.5 Satellite image of Everglades depicting principal water management units. Satellite image of South Florida with boundaries of major management areas identified (Courtesy Everglades National Park)

The first two accounts proved irreducible to convenient units of analysis that fit the rationality of cost-benefit analysis.[8] Politically, the Carter Administration's attempts to develop these accounts, were abandoned by the Reagan Administration.

[8] To those who would argue for proxy ways of measuring environmental quality and social wellbeing, we would argue that a fundamentally new epistemology is needed.

The absence of considerations of environmental quality and social equity facilitates the exercise of unilateral power. Such cost-benefit analyses, as practiced by the Corps, contribute to the further widening of economic disparities and environmental degradation. For instance, turning wetlands into artificial units of analysis that can be "rolled around the landscape" for the convenience of the policy analyst ignores fundamental ecological principles.

The western state interests in maximizing economic benefits aided by economists from the Deputy Assistant Secretary of the Army for Civil Works, re-sculpted Reagan's water policy to remove from consideration the environmental and social dimensions the WRPA had intended. One of the same economists from the Assistant Secretary's office was later dubbed "Dr. No" for his unilateral objections to the Kissimmee River Restoration design.

When the Senate demanded that the Corps review the project, the economist in charge of the review referred to the project as being in a "glass box" in a ultimately failed attempt to avoid setting environmental precedents for subsequent water projects to mimic. This exercise of administrative fiat was reversed, at least in principle if not practice, when Congress in 1986 enacted Section 1135 of the Water Resources Development Act allowing environmental projects inside the policy tent. S.1135 provisions were used 4 years later to support the arguments for the Kissimmee River Restoration.

The Kissimmee River Restoration (KRR) established new design standards for ecological restoration that the Corps of Engineers Principles and Guidelines for project planning still do not reflect. The KRR project's detailed design offered three policy options; all were composite, irreducible solutions that addressed effectively all four WRPA accounts to the satisfaction and support of the Kissimmee River basin constituencies, as well as state and congressional policy makers. The options were conceived as whole, complete, stand alone solutions. In addition to achieving hydrologic determinants of ecological integrity, they met flood control standards, enhanced sports fisheries both in the take and quality of the experience, while improving grazing conditions through periodic inundation of the flood plain, which raised water quality as well. The Kissimmee River Restoration succeeded in "lifting all boats;" no interests or constituents were sacrificed or left behind in the solutions (an example of 80–90% conflict resolution).

The decision document contained no benefit-cost analysis, and to ensure that none was applied in attempts to fragment the composites, the stipulation was added that if none of the composite solutions were found acceptable by the Corps of Engineers, the restoration project should be abandoned entirely. The project was accepted, authorized and funding appropriated. Defying the "efficiency" and "one size fits all" McDonough and Braungart (2002) mentality often applied by the Corps, the most acceptable solution was also the one that answered the questions "what will it take" not "what is the least cost alternative." The outcomes (e.g., return of colonial wading bird rookeries, quality sports fishing) of the restoration testify to its value far surpassing expenditures and expectations.

Despite myths to the contrary, the Kissimmee River Restoration was neither designed nor implemented by the Corps. The SFWMD recommended that construction management of its design be completed by the Corps. SFWMD had no such capacity at the time. Kent Loftin (Loftin et al. 1990), the team leader for the restoration project, made the construction management recommendation with the stipulation that a team of South Florida Water Management District scientists and engineers oversee compliance of construction and field adjustments to ensure they were in keeping with the spirit and letter of the ecological design.

The second case can be gleaned from the National Research Council report entitled *Inland Navigation System Planning: The Upper Mississippi River-Illinois Waterway* (2001). The report examines a feasibility study that the Corps was conducting to determine the economic viability and environmental implications of lock expansion on the Upper Mississippi River (UMR). The Corps UMR economic study cost more than $50 million. When the study's chief economist Donald C. Sweeney filed a whistleblower suit with the Office of Special Counsel for abuses of power by his superiors, the U.S. Army acceded to a study review by a National Research Council expert panel.

During a workshop on the restoration of the UMR in Winona, MN (March, 1999), a small group of river biologists talked with Sweeney about his account of being pressured to change the results of his research that concluded that "the cost of such a large-scale construction project [expanding locks] far outweighed the benefits." Sweeney's charges were upheld.

To draw this section to a close, the powers of dominion not democracy are far too frequently reflected in water institution policy making. While the missions of public water institutions reflect democratic aspirations, these principles are often undermined "innocently," as John Kenneth Galbraith would say, through successive generations of decision making. We concede that unilateral power is necessary on occasion (in the wake of natural disasters) in the name of the "greater good". However, the examples offered above speak to a decision record in water management that is skewed to powerful economic interests; the very few, not the many; the vested interests whose power fosters social wounds in the form of inequities that are life denying. There are no innocents save the children who will have to endure the consequences of the human predicament. We will refer to this systemic problem as the *Hamartic Syndrome* after the Greek word "*hamartia*" ("*injury through ignorance*[9]") for which there is no excuse. At best we are guilty bystanders who have failed to assume responsibility for living with as well as profiting from nature's dynamism.

Should the reader consider the Kissimmee River Restoration saga an aberration or an exception to the rule in its exclusion of cost benefit analysis, the authors suggest reading *Muddy Waters* (1950) by Arthur Maass, one of the leading theorists on the subject. Particularly illuminating is the scalding forward by Secretary of the Interior Harold Ickes, who served for 13 years under President Franklin Delano Roosevelt. Maass' chronicles the political ends to which such analyses were used. A more recent work of John Barry, *Rising Tide* (1997) details the social injustice

[9] "Ignorance, the stem and root of all evil" [Plato and echoed by St. Augustine, Robert Browning]

and environmental degradation along the Mississippi River by the engineer-led and politically powerful New Orleanians who dictated policy for over 100 years.

Ironically, from the scientists whose discoveries in dynamical systems have been transforming our technologies and economies in general, the question is being raised "what will social reality (human nature) need to become?" (Gilbert and Epel 2009; Kauffman 2008; Meyer 2006; Prigogine 2004; Crutchfield 1994; Gell-Mann 1994; Margulis and Sagan 1995; Jablonka and Lamb 2000; Capra 1996; Popper 1989; Jantsch 1981; Waddington 1975; Michael 1973; Heisenberg 1971; Polanyi 1958). The voices from path-breaking scientists in dynamical systems thinking have sounded the claxon for decades. As Alexander Solzhenitsyn (1974) observed, and what Conrad Waddington (1975, 1978) obsessed over in his last years, if we do not change social reality "The Club of Rome has done the arithmetic: we have less than a 100 years to live." The point is not whether Solzhenitsyn, is right Ravetz (1986), Funtowicz and Ravetz (1993), we live life forward into the radical uncertainty of the post-modern era acting as if we knew the future when we don't.

5 The Everglades: "The Saga the World Cannot Set Aside"

For whatever reason, as Nat Reed (a leading environmentalist from Florida and former Assistant Secretary of Fish, Wildlife and Parks at the Department of the Interior) is fond of saying "the Everglades are a saga the world cannot set aside." Reed's grasp of the nature of the struggle, its singular and desperate fight to the finish, gives this chapter its *raison d'être.* Perhaps one has to be immersed in the flow of this saga to come to terms with its immensity and understand its presence on the global stage.

Our hope is that the struggle between the powers of dominion and the powers of relationship over "getting the water right" in the Everglades will open vistas and pathways for the reader that are marked surprisingly, not by more disappointment and failure, but by patches of creative advance in our ceaseless evolutionary quest for excellence. And, by so doing, we hope to help pull us back from the brink of triggering social and ecological avalanches of "dying ways of being in this world" born of Per Bak's (1996) sand piles (Self Organizing Criticality) that haunt Stuart Kauffman (1995) and us.

We conclude this chapter with a proposed framework of Policy Design for Evolution (PDE) drawn from the convergence of individual theorists in dynamical systems. PDE is based on the concept of Prosilience – the emergence of the prospective mind of man in becoming future responsive. Unlike E.O. Wilson's "consilience" the jumping together of advances in diverse disciplines and C.S. Holling's "resilience" that emphasizes the adaptive behavior of systems manifesting multiple stable states – prosilience (from the Greek God Proteus) moves beyond "keeping options open" and "persistence in the face of adversity" to mimicking nature's spontaneous emergence, creating options for the future.

6 'DECOMP' The Plan to Restore Flows

6.1 Decompartmentalization of the Everglades

Embedded in the Comprehensive Everglades Restoration Plan's 60-plus projects (fragments of a restoration vision) is the decompartmentalization (DECOMP) of the interior levees, pumps, and canals known as the Water Conservation Areas. If the Everglades' is to recover its soul, it will be through reviving the pulsating heartbeat that was visible in the historic natural flow regime.[10] The DECOMP Adaptive Management Plan (DAMP) is a large-scale experiment, and a most necessary strategic action in beginning to reveal the relationship between flow regime and ecological response that could eventually take the Everglades system off 'life-support.' This experiment could help reduce uncertainty, build trust and develop a shared commitment to risk taking not just for one patch of restoration, but also for the search for excellent solutions inherent in becoming future-responsive at multiple scales.

Flow is the key to the Everglades (Light and Dineen 1994). Flow is the concrete (Polanyi 1958) and heuristic expression that can instruct us in nature's dynamical operating rules for the Everglades if we would only be actively open to being affected by these operating rules. Such a stance requires relational and not unilateral power.

It is possible to be distracted by the "whirligigs and heehaws" such as Former Governor Crist's proposed purchase of sugar producing lands in the Everglades Agricultural Area, of unilateral power's unrelenting pursuit of projects for water supply, water quality, and flood control. For example, the SFWMD made a high-level operational and policy decision in 2003 to walk away from DECOMP as a priority in favor of Acceler8 (a set of reservoir projects along the Caloosahatchee and St. Lucie channels). Questions from informed onlookers have justifiably raised questions about the District's restoration intentions every since.

It has been argued by the SFWMD that these unilateral measures were essential for restoration to proceed. However, the countervailing line of reasoning is that unless flow entrains the other relationships (such as the purchases in the Upper Chain of Lakes basins as was the case in the Kissimmee River Restoration), the restoration of flow in CERP is simply a shell game by brute forces securing the water resources requirements for South Florida's coastal developments. Indeed, other agencies including, especially, the Department of the Interior, expressed these concerns and reaffirmed the high-priority of DECOMP as essential to restoration.

Ecosystem restoration is an emergent response in which humans join with nature in a complex dialogue involving multifunctional webs of relationships with numerous

[10] The reader must not conclude that the authors dream of a return to 1900; we seek only the return of functionality that makes the Everglades, the "Forever-glades".

causations and feedbacks that are only partially observable or understood. Linear processes referred to as "planning" are anathema to relational problem solving for the simple reason that problems and solutions cohabitate in the midst of extreme emergent complexity (Ravetz 2006). The notion that problems can be isolated and arrested from the flow we call "the problem" is not possible. In complex systems the problem only becomes apparent as the solution begins to emerge.

6.2 The Nature of Human Nature

The Everglades was the "River of Grass" that Marjorie Stoneman Douglas (1947) memorialized. What natural remnants remain of the pre-1900 Everglades (see Light and Dineen 1994; Davis and Ogden 1994) may qualify as little more than a "ghost" today. Many (most) people cannot sense the scope of loss of natural systems resulting from human action. As a consequence, appeals for reversal of these losses and natural system restoration are criticized as unrealistic (an illusory attempt to return to a bygone era). Such criticisms are, in essence, a red herring, since restoration of natural systems cannot imply a disregard for "balance" that accommodates continued human presence and significantly restored natural systems.

Humans exist between the veil of forgetting and the veil of the unknown; pleading ignorance of the first while terrified of the second. As one environmental engineering intern to the SFWMD from the University of Florida remarked during a TV special on the Everglades (summer of 1994): *"What if a few more species go extinct; they have been going extinct all my life and before I was born."* Western civilization induced this intergenerational and dangerous veil of forgetting that masks the 'injury through ignorance' syndrome that dominates modern man's relationship with nature. Unlike the Lakota Tribe of Redwing, MN, we do not have wisdom figures who can enumerate the 10-generation history for our communities' sense of place.

Our culture's "rational actor" view of the world tolerates this forgetting of what the Everglades once were. The nature of its irreproducible aquatic and terrestrial ecosystems is gone despite attempts to renew these values using or misusing the billions of dollars set aside for science, policy, and programs. Few realize the implications of the admonition that "*mans' fundamental understanding and relationship with nature must change*" if there are to be "Forever-glades" in the planet's future (Kauffman 2008).

Today, the Everglades are more vulnerable than ever (Herring et al. 2006). The introduction of pythons and boa constrictors into the ecosystem (Cubie 2009; Goolsby et al. 2006), and their penetration throughout the Greater Everglades Ecosystem in the span of a decade is one of the more recent signs of the system's loss of integrity (Brooks and Jordan 2010). Add in the conversion of sawgrass to cattail as water quality has degraded, the presence of mercury from power plants, endocrine disruptors from chemical agriculture, imports such as Brazilian Pepper and *Melaleuca* from Australia, and one has the makings of a toxic soup.

6.3 Concrescence – Discovering the Unity in Diversity

This chapter, if it is to make any contribution at all, argues that relationality must start tearing down the imaginary veils that entomb our past and deny access to the future, while 'blinking' at the depth of experience that has become a cultural 'blind spot' (Arthur et al. 2000).

Our cultural "blind spot" is our almost sub-conscious and instantaneous separation of objects from relationships embedded in experience. The centrifugal force of our cognitive powers tends to rip the rich mosaic of reality, separating its interwovenness, which diminishes the meaning of all our experience. We see only what we select for focal attention. We ignore what might be referred to as our sensibilities, in becoming aware of the hidden relationships for solving complex problems and launching our imagination in their pursuit. Poincare referred to these as special "anticipatory gifts."

Concrescence is the process of making concrete, a "unity" or "solidarity" and a "presencing" of the rich contextual fabric of experience as we anticipate taking action. Alluded to by Poincare's "special gifts," Polanyi's "tacit dimension," and Gigerenzer's "gut feelings" (the intelligence of the unconscious), these presencing experiences privilege us to clues and intuitions born of sensibilities deeper than reason can offer up to the future. Concrescence is the "solid-rarity" of each moment's understandings of the influences of the past represented in the fabric of the present, as the birthing of future potentialities.

Concrescence is a personal openness to being affected by dynamic forces that influence us almost unconsciously in the process of facing an unknown future. We live life forward acting as if we know – but we don't. In a world filled with ad hoc, once and done, "move on to the next item on the agenda," our nature exposes its incapacity for Prigogine's repeated urgings for opening a new "dialogue with nature." These representations of concrescence sound strange to western ways of reasoning, but like the awkward, somewhat paradoxical image from antiquity of a snake eating its tail, (*Ouroboros*), prefiguring the notion of feedback systems (cybernetics), quantum physics discovered complementarities in light as a wave and as particle. So, too, is such complementarity possible as we think about Everglades' restoration. Nature is not the enemy, it is our greatest ally.

The implication of concrescence for flows in the Everglades is that for Everglades restoration, specifically, and the flourishing of nature, in general, we as humans must change our image of social reality. The image of man affects the nature of man, and we must be willing to be affected by the influences of others in affecting others as we form actions intent on a future of "becoming with" not in opposition to others.

If anything, in our addiction to certainty, we have imagined nature and our neighbor into being our enemies. Providentially, human nature is malleable, despite strong evidence to the contrary. Western civilization, which now dominates global scientific and technological thinking, must take a leap of faith that penetrates the veil of the unknown, to embrace *relationality* as the image of man and ways of problem solving that have stifled emergence of creative options for the future and threaten our existence.

From a linear, brutish, and one-sided conception of reality born of fear that seeks domination, certitude and control, we must fashion a new social reality and image of human nature. The Everglades is the saga that the world refuses to put down, because it is a microcosm of the human predicament and the windsock alerting others of any shifts in future direction of human nature and our relationship with the biosphere (Jung and Sabini 2002).

"Decisions of record" are concrescent, whether intended or not. They are a gathering of the multidimensional influences manifest in nature of a highly contextual reality. The decision to implement the DAMP design presences all the apparent or real constraints, biases, history of past efforts, risks, and uncertainty as well as past alterations to and intentions for the aquatic ecosystem. None of this can be lost in our deliberations.

The forces of domination squeeze the life out of what is authentically relational but turns viciously "rational" in the choices before us. At one meeting where restoration decisions of record were being made in April of 2006, a project that would have set tens of thousands of acres aside north of Lake Okeechobee for water quality enhancement and ecological restoration was rejected because the project's operation would suspend navigation for recreational use for a maximum of 5 days each year based on an antiquated and unemployed state law. As the decision was handed down, the project manager stood incredulous before the dais, until the next presenter was summoned to the podium.

6.4 "No Man's Land": Tamiami Trail and Taylor Slough

Since Art Marshall sketched a one-page plan (c. 1970) for Everglades restoration that garnered support from over 250 organizations,[11] major fights for domination over six ecologically sensitive zones have erupted in the greater Everglades[12]: the Kissimmee River Restoration, Florida Bay, the back pumping into and nutrification of Lake Okeechobee from the Everglades Agricultural Area that also is the source of nutrient-laden water auguring, the east and west outlets to tide from the Lake, the conversion of sawgrass to cattails to the south in the Water Conservation Areas, and the Tamiami Trail/C-111 (water deliveries for the park).

Of the six ecological battle zones, the most incalculable ecological harm and unwarrantable clash of wills for political, administrative and scientific domination has been the "no man's land" of Tamiami Trail and C-111. Historically, on the surface, one could say the combatants are the development versus the preservation interests, but that denies the perverse and intricate variety of the interests at stake. Stereotypes simply fail to do the conflagration justice. There are many levels at which pitched battles, skirmishes, and sapping efforts have been conducted.

[11] Based on a personal interview with Art Marshal at his home in Ingersoll, Florida, 1980.

[12] The 1967 Jet Port showdown not-with-standing.

However, there seems to be no limit to the cost of policy failure (Häfele 1974), all sacrificed in the pursuit of power by special interests of every stripe and color by whatever means at their disposal.

Through four decades of anguish and successive episodes of hope followed by despair, the first author argues that the vast majority of the rubble and casualties strewn across this no man's land is due to the clash of unilateral versus relational power, whose manifestations have gone vaguely disguised in the mêlée. It is the global struggle over the powers of fragmentation and flow in both concrete and mythical terms. Reality comprises both particles and waves. But our perspective has been so lopsided at every level of knowing and action in favor of the discrete, the certain, and the stationary, that we flout the importance of flow and pay no heed to the intricacies and centrality of flow.

The history of water resources in the Everglades has been about everything but natural flow (Light et al. 1995). The paucity of understanding about the genesis and development of flow patterns in relationship to the systems' structure, function and processes is unfortunate (Science Coordination Team 2003). The first author mistakenly assumed that "getting the water right" meant "getting the flow right." Substance versus process rears its head everywhere we turn. The combatants begrudgingly conceded to the construction of a one-mile "bridge" on the Tamiami Trail, but the flow response study is still on the shelf as of this writing. The challenge nobody seems to be able to mount is an appropriate response to flow since testing flow patterns could threaten tightly circumscribed political positions. In defense of the successful launching of the one-mile bridge in 2009, some of the hurdles mentioned in this section were effectively surmounted. The Secretary's Office of the Department of Interior and the singular determination of Deputy Secretary Lynn Scarlet need to be applauded.

We have been preoccupied with drawing lines and distinctions to influence, guide, adjust, manipulate, shape, control, or transform the Everglades natural environment (see Fig. 13.3 the depiction of the Central and Southern Flood Control project). A close inspection of Fig. 13.2 will reveal that to advance the ends of powerful interests, intentions to restore natural flow in a holistic and ecological sense have been cast aside for more intensive plumbing. If we took flow seriously, CERP would have to go back to the drawing boards yet again and make a serious effort to consider sorting out the hydrological conditions for ecological functionality at every step of the restoration from Florida Bay, north.

Everywhere we have fragmented flows we have left enduring ecological wounds – *hamartia* – or "injury out of ignorance." But the interpretation of "ignorance" in the minds of Plato and Socrates signifies injustice as well as lack of understanding, knowledge, experience but not innocence. Attending to flow would mean attending to the hamartic harms we have inflicted and would rather not revisit. The Decompartmentalization Adaptive Management Plan (DAMP) was an attempt to design an experiment to begin the healing, but was stopped for reasons that remain obscure to the authors, but clearly reflect a lack of shared response-ability. Although construction of a one-mile bridge along the Trail has begun, there is still no strategy for restoring flow. For DAMP, it certainly was not due to faulty design, exorbitant cost, and unavailability of resources, lack of ripeness for action, justification for conducting the field test, or the lack of legislative mandate.

This is not about "isms," (dogmatism or idealism); rather this is about choosing nature's unrelenting press for life (spontaneous emergence) over its destruction. Everywhere that flow has been stopped or stabilized the faucet of nature's inherent creative advance has been diverted and disrupted. The universe's surge for evolutionary excellence has been reduced in the Everglades to the lowest common denominator – reminding the authors of von Clausewitz's renowned definition of war – "War is the pursuit of politics by other means" (von Clausewitz 1836). Could the same be said of restoration of the Everglades? We turned the "river of grass" into patches of weeds.

We have made the Everglades in our own likeness, a heart of stone or, to be more precise, concrete. We speak of 'balance' between nature and humans. So what should be the balance between our use of unilateral power and that of relational power? Clearly, our inability and manifest unwillingness thus far to decompartmentalize the Water Conservation Areas so that flow can be restored gives us some indication of how woefully inadequate the restoration has been.

7 Anatomy of the Everglades' Flow Test Failure to Launch

What does an attempt to shift from unilateral power to relational power look like? What form do the barriers to relationality take? How would the issues of constraints, conflict, uncertainty and risk-taking be encountered and addressed? This section will attempt an analysis of the DAMP failure to launch. It is a truncated analysis so that more space can be devoted to setting forth an alternative to ways of reasoning that reinforce unilateral power. For more background analysis of the issue, the reader is encouraged to consult the US Geological Survey's Everglades website (Sophia).

7.1 Restoration Legislation Related Issues

The Water Resources Development Act (WRDA) of 2000 authorized modifications to the Tamiami Trail component of the Everglades National Park to improve restoration required for recovery of a regionally integrated ecosystem and to achieve the ecological targets of the Comprehensive Everglades Restoration Plan (CERP). However, WRDA 2000 stipulated that no appropriations of funds should be made to construct the Water Conservation Area 3 Decompartmentalization and Sheetflow Enhancement Project (DECOMP) until the completion of the Modified Water Deliveries Project (MWD or 'Mod Waters'). The fates of DECOMP and Mod Waters are inexorably linked and should have never been parsed into separate congressional authorizations.

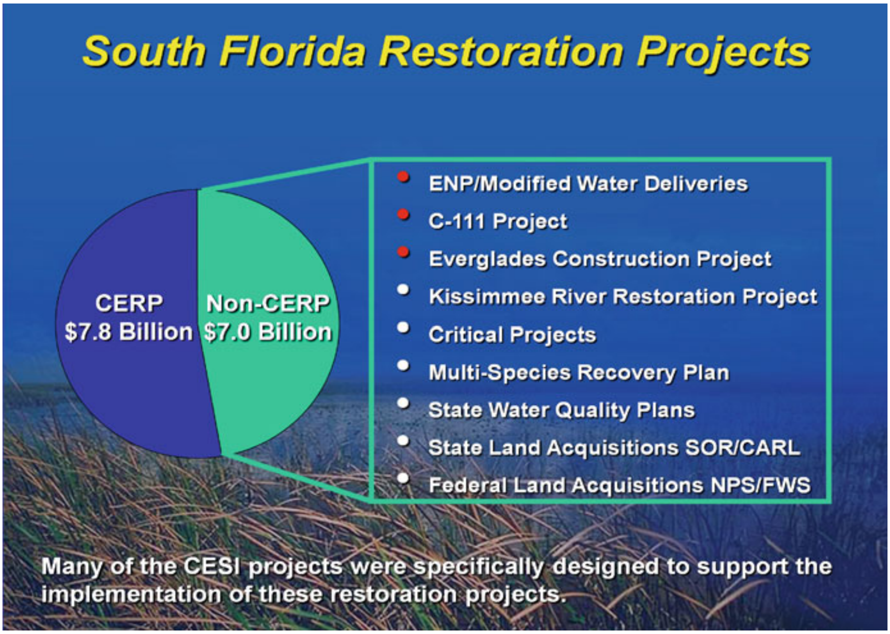

Fig. 13.6 Pie chart showing the relationships between CERP and Non-CERP (Everglades National Park) authorized projects (Courtesy Robert Johnson, ENP)

Mod Waters activities were a set of Everglades National Park efforts authorized by a different suite of congressional committees that oversee the Department of the Interior than those that drafted the WRDA legislation (water and transportation committees). These committees represent the structural schism in federal government that initiated and perpetuate interagency power struggles at the expense of effective governance. This crippling stipulation over appropriations for DECOMP fueled agency animosities, created confusion, and spawned duplication of effort, aiding those bent on stonewalling any effort to restore flow (Fig. 13.6).

The dividing line between philosophies, constituencies, congressional appropriation committees, and agencies was Tamiami Trail. In effect, a "No Man's Land" was created despite the fact that Tamiami Trail is the linchpin to reestablishing ecologically responsive flows from the Water Conservation Areas into the Everglades National Park and Florida Bay, constituting the overriding bulk of the environmental benefits associated with the CERP plan.

Enough was known regarding restoration guidelines (Science Coordination Team 2003; Davis and Ogden 1994) to begin experimental water deliveries using adaptive management (Walters and Hilborn 1976, 1978) to improve water flows to the park. The work of the Science Coordination Team (2003) represented an interagency consensus among Everglades' scientists on the need to proceed with experimental flows to reduce uncertainties. The Science Coordination Team report documented convincingly that flow studies (i.e., field tests, environmental studies, pilot tests) were absent in the scientific literature. Everglades' scientists did not have enough flow regime information to base DECOMP or Mod Waters decisions on an advanced restoration mode. No amount of modeling could replace this fact. Without the flow-response curves, computer simulations are incapable of addressing the unknown.

The degree of disconnect between flow and ecological response was profound. Despite consensus on the need to investigate the role of flow for DECOMP, there were scientists, particularly from the Everglades National Park and the Florida Game and Fish Department, who did not want the experiment to move forward. Issues were raised regarding the adverse impact of a flow experiment on tear-drop shaped tree islands, especially in Water Conservation Area 3-B. One scientist stood and shouted in a November, 2005 workshop in Ft. Lauderdale: "Who cares about the flow regime as long as the vegetation comes back." The authors concede that Endangered Species issues were at stake, but a multi-species approach to restoration had been in effect *de facto* following a review by a select group of scientists headed by Gordon Orions in 1992.

Although some impact (positive or negative) on the tree islands could be anticipated, the islands were born of disturbance regimes (flows, hurricanes, drought, and human alteration), the worst being the man made Central & Southern Florida Flood Control project (see http://en.wikipedia.org/wiki/Everglades). If the tree islands that had formed over millennia could not withstand a 5-year flow test to gain vital knowledge that would repair the ridge and slough morphology, it raises the question of whether the islands might be little more than relics of a by-gone biophysical regime, artificially perpetuated in a non-ecological manner.

From the personal observations of the first author, the biggest threat induced by the proposed flow experiment to the prevailing "myths of how the Everglades worked" was motivated by self-serving interests. Those who received revenues from licenses for fishing and deer hunting, or from water recreation using commercially lucrative high-powered water craft, and from the feared a reversal of some theories published in peer-reviewed scientific journals the most recalcitrant.

The design of DAMP flow experiments by an assembly of some 35 scientists and engineers needlessly started from scratch. The Kissimmee River Restoration was proof-of-concept that active experimentation worked to gain knowledge of extant unknowns and uncertainties (for restoration involving removal of canals and levees – e.g., advantages of alternative modes of backfilling and degradation of levees). Experimentation coupled with physical and numerical modeling and biological field studies had proven to be a fast, cheap, and effective way to restoration. The design of the whole Kissimmee River Restoration project only took 4 years.[13]

Arguments were advanced by Everglades scientists that the lessons learned from the Kissimmee River Restoration were not applicable to dismantling canals and levees needed to begin improving flows south of Tamiami Trail. The reality was that

[13] See narrative provided at this website for more detailed discussion www.**everglades**plan.org/pm/projects/docs_12_wca3_dpm_ea.aspx

none of the scientists that had worked on the Kissimmee effort were involved in the DAMP design. Despite strong leaders like Fred Sklar, Joel Trexler, and Tom Van Lent, the core of scientists for DECOMP were young and lacked experience and confidence in themselves and the novel and arguably risky methods employed in the Kissimmee, notwithstanding the risks of continued inaction. There had been a generational turnover. Also, innovation in DAMP was constrained by the preponderance of special interests leaning over the shoulders of "their" scientists.

The longer-term distractions and delays caused by a 2-year rule making ("Pro Regs") exercise after the WRDA authorization (2000) and before the Comprehensive Everglades Restoration Program (CERP) could really begin in earnest should not be ignored. The CERP was silent, as well, on who was responsible for implementing adaptive management despite the centrality of the notion expressed in the authorizing legislation.

Eventually, an interagency leadership team assumed the task with the responsibility but not the authority to do so. Also, the comprehensive plan divided "restoration" into 67 discrete packets that were sequenced; this further confused, unduly fragmented, and hamstrung restoration efforts. Much of the flexibility needed for implementing adaptive management, for making mid-course corrections and to design experiments that crossed plan-component lines in the CERP plan (dubbed the Yellow Book) was opposed.

7.2 Institutional Confabulation over the Tamiami Trail

The administrative battle over water delivery related issues at Tamiami Trail dated back at least to 1970 when Stan Caine, Assistant Secretary for Fish, Wildlife and Parks, was called upon to "split the baby," by establishing monthly water allocations from the C&SF Project to be delivered to the park, regardless of flow timing or duration (Light and Dineen 1994; Light 1983). Worthy of note is the fact that from 1963 to 1970 no water had entered the park during the C&SF project construction. The initial C&SF project design contemplated no deliveries to the park.

The "swoosh" in Fig. 13.2 figuratively represents the historical direction of flow patterns and the structures that stand in the way of decompartmentalization north of the Tamiami Trail and from the eastern flank of Shark Slough involving the C-111 basin/Taylor Slough. The goals of these two efforts were to modify water deliveries to the Everglades National Park and restore the ecosystem in Taylor Slough and the eastern panhandle of Everglades National Park while maximizing flood damage reduction. A brief description and summary of Taylor Slough/C-111 followed by Shark Slough is offered. The fight over Taylor Slough and C-111 (Fig. 13.2) is beyond the scope of this chapter, but the knowledge of the Taylor Slough/C-111 source of water for restoration along the park's flank gives a holistic picture of flow efforts.

Refer to Fig. 13.2 Project Features Map of Water Conservation Areas and Shark and Red Lines that demark the Taylor Slough/C-111 project features along the eastern frontier of the Everglades National Park.

7.3 Taylor Slough/C-111 Basin

The 1989 Everglades National Park Protection and Expansion Act (Light and Dineen 1994) directed the Corps to re-engineer water works and operations in the C-111 basin of the East Everglades. In addition, the U. S. Fish and Wildlife Service (FWS) proposed an east–west spreader canal between C-111E and US Highway 1. The FWS also proposed the plugging of C-109 and C-110 to promote sheetflow and to provide dry season refugia in the panhandle of the park. Sheetflow would be provided by overflows from C-111 through gaps in the southern spoil mounds.

With the passage of Public Law 104–303, the Water Resources Development Act of 1996, Section 528 of that law authorized the Corps to protect water quality by constructing features determined necessary to provide sufficiently clean water to the Everglades National Park. The specific objectives of the C-111 project included most of those that had been under consideration by the Corps for almost 20 years.

The first objective in the C-111 basin was to restore historical hydrologic conditions, which included eliminating damaging flood flows to Manatee Bay/Barnes Sound partly by degrading levees to increase flows to northeast Florida Bay from the lower C-111. These water control modifications would go a long way in protecting the natural values along the eastern flank of the Everglades National Park exposed to farming and residential and commercial development. This effort required maintaining the level of flood damage reduction to ensure that C-111 project waters diverted to Everglades National Park met all applicable water quality criteria. The last objective was to explore opportunities for an enhanced level of flood damage reduction for the C-111 Basin east of L-31 N and C-111 canals consistent with the restoration objectives.

To give the reader some perspective of the extent of gridlock involved in implementing these measures, the measures for improving C-111 were essentially the same as those presented to SFWMD staff by the South Atlantic Division (SAD) of the Corps of Engineers during the summer of 1982 at a meeting the first author attended with Walt Dineen, chief biologist, and Jorge Marban, chief hydrologist. SAD promised to have a feasibility study to circulate in 6 months. The toll in terms of environmental degradation that continued unabated for over 20 years, not to mention the waste of manpower and bureaucratic red tape, is inexcusable and qualifies at the very least as malfeasance.

On the way to the meeting Walt stopped to inspect Taylor Slough. The slough was brimming with lush aquatic vegetation and crystal clear water with gar and bass in the current. The last day of the first author's tenure with the SFWMD, Steve Davis and the first author took an aerial tour by helicopter of the southern Glades and stopped at Taylor Slough. It was bone dry, woody vegetation had taken hold of the channel, and there was no aquatic life to be seen. The sense of personal loss to the first author was palpable.

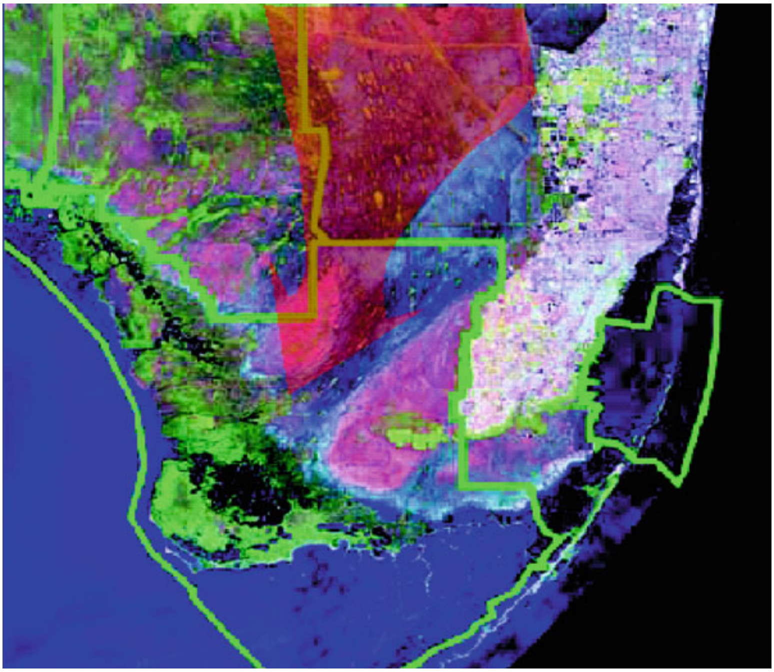

Fig. 13.7 This figure is a satellite image of the National Park Service holdings in South Florida, highlighted in *red* is the current directional flow of Shark Slough (Courtesy of the South Florida Water Management District)

7.4 Tamiami Trail

In 1989, the Everglades National Park Protection and Expansion Act became law. In effect, the law resolved the land rights issues of hundreds of landowners (a.k.a., squatters) on an 8.5 square mile area in Northeast Shark River Slough of the Everglades National Park. It also authorized the Secretary of the Army, in consultation with the Secretary of the Interior, to design and construct modifications to the Central &Southern Flood Control Project to improve delivery of water into the Everglades National Park and restore as much as possible the natural hydrologic conditions within the Park.

The historical Shark Slough flow pattern (highlighted in red) (Fig. 13.9) below and the flow pattern extended to the full width of the Shark Slough Drainage basin and, during high-water periods, would spill over into the Taylor Slough drainage basin (Figs. 13.7 and 13.8).

In contrast, the current flow pattern (Fig. 13.9) is largely confined to western region of Shark Slough with very little water (smaller red arrow extending down and to the right in discharge to Northeast Shark River Slough (Fig. 13.9).

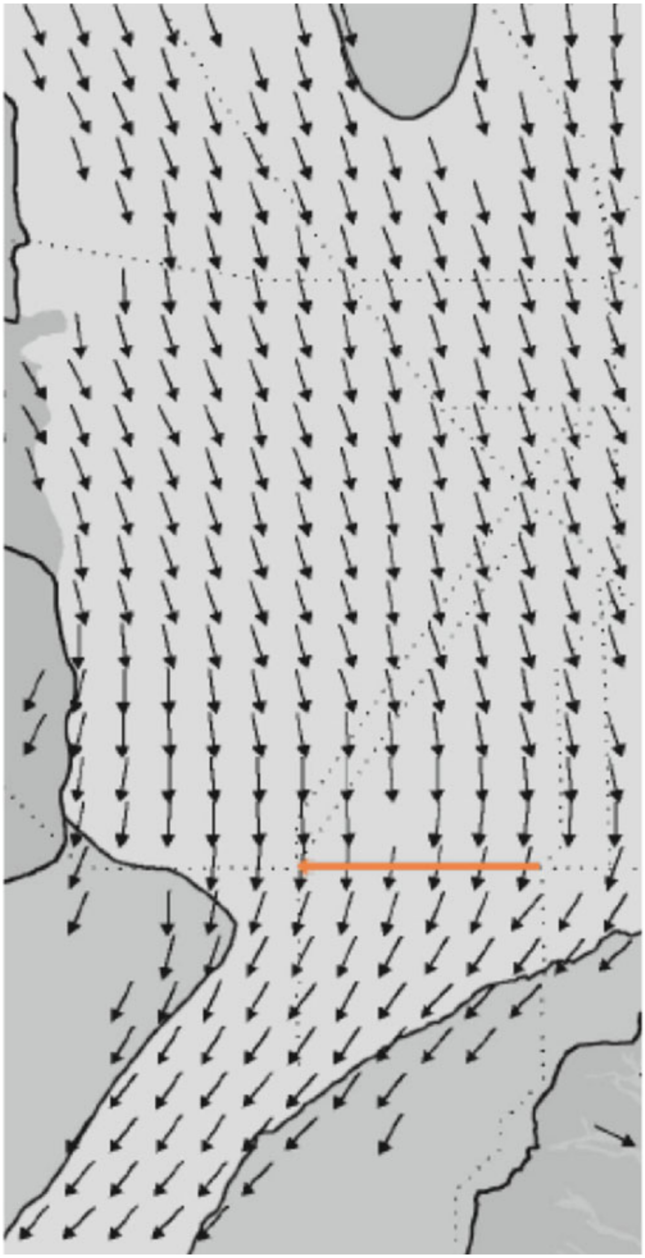

Fig. 13.8 This figure shows how the seven computerized map of historic flow through Shark Slough flow pattern was modified from 1970 as a point of comparison. The thin *red line* indicates the location of the S-12 structures (Courtesy of Science Coordination Team)

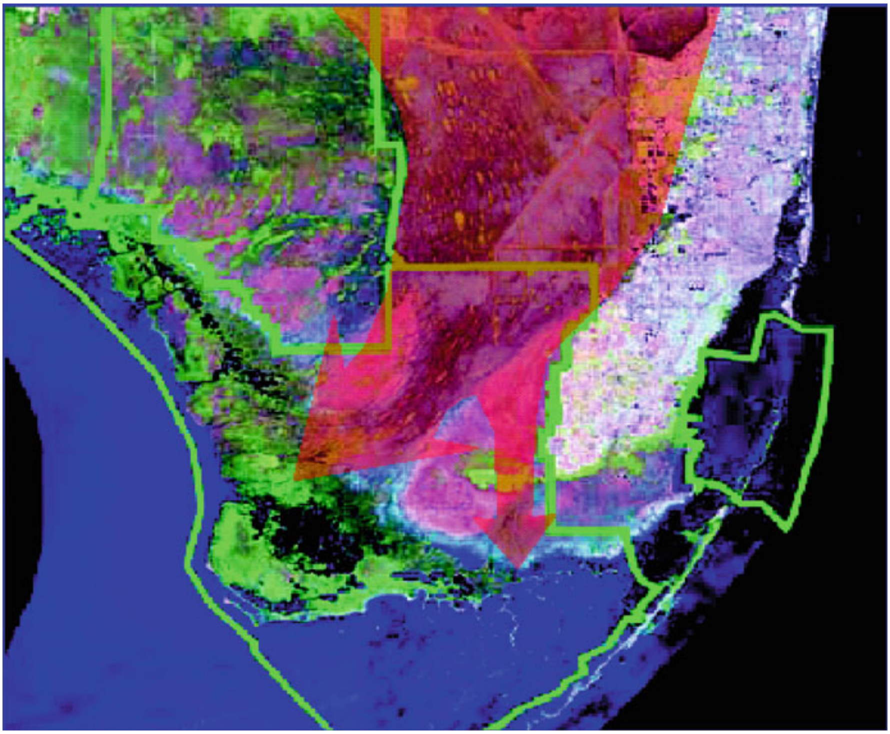

Fig. 13.9 The satellite image of the Everglades National Park and surrounding preserves shows how flow from Shark Slough would spillover and contribute to the Taylor Slough flow (Courtesy Everglades National Park)

The Experimental Program of Water Deliveries was terminated in 1989 based on concerns of the U.S Fish and Wildlife Service regarding the status of the endangered Cape Sable seaside sparrow. In response to these concerns, the Corps of Engineers initiated two interim operational plans for the benefit of the Cape Sable seaside sparrow, while preserving other C&SF project purposes.

The objectives of the water delivery modifications across Tamiami Trail included changes to the schedule of water deliveries so that fluctuations were in consonance with local meteorological conditions, including the provision for long-term and annual variation in ecosystem conditions in the Everglades National Park. Further, restoring WCA 3B and the Northeast Shark River Slough as a functioning component of the Everglades hydrologic system was proposed. Also, the park proposed adjusting the magnitude of water discharged to Everglades National Park to minimize the effects of too much or too little water while maintaining the mitigation for project-induced flood damages in the East Everglades, including the 8.5 Square Mile Area, the Osceola Indian Camp, and the Tiger Tail Indian Camp.

Unfortunately, these objectives were essentially the ones that guided actions taken from 1983 forward. Given the urgency of the ecological situation in the park, the pace of action and the predominance of inaction are highly unfortunate but characteristic of the times.

7.5 Lack of Action

Since 1929, the Tamiami Trail (U.S. 41) has provided a vital transportation link from Miami-Dade County west to Monroe County and Collier County, Florida. The existing link is important for tribal, commercial, and emergency (e.g., hurricane evacuation) use. The existing roadway of Tamiami Trail is subject to high traffic loads as well as periodic high-water events. Built on muck, it is constantly in need of repair. From the 1980s to 2006, the road, culverts, the C-12 structures and canals were virtually insurmountable barriers to Everglades' restoration, along with ineptitude at the state and federal level for not improving a vital hurricane evacuation route.

There has been a succession of data analyses, supplemental Environmental Impact Statements, revised General Design Memoranda, new information requiring revised modeling runs, and worry about the most optimal solution for providing the increased conveyance capacity and connectivity required to meet the goals and objectives of both Corps CERP implementation and the Everglades National Park's plan to modify water deliveries.

In addition, there were concerns regarding the Florida Department of Transportation requirements that the current elevation of the 10.7-mile portion of Tamiami Trail between the S-334 and S-333 structures must be raised. A bridge or causeway that covers the 10.7 mile length of the Northeast Shark Slough flow-way was considered. Even though this concept would provide the level of restoration benefits that were expected under the CERP, this alternative was eliminated from consideration.

In the first author's judgment, collaboration among the Florida Department of Transportation, Everglades National Park, Corps of Engineers, and South Florida Water Management District could have resolved all issues in 2006 and erred on the side of the environment, but participants failed to do so. The reasons for this are manifest – a variety of legalistic details, easement deeds, land transfers, but they boil down to "red tape" that signals a failure and need for overhauling decision processes in a way that would facilitate and expedite more holistic approaches to restoration efforts. A raised roadway over sloughs is hardly a novel concept or an unusual construction method over sand and muck. In Louisiana, there is an 18.2-mile (29.3 km) stretch of elevated highway between Lafayette and New Orleans.

One need only experience the interstate highway (I-95) turned parking lot when evacuation orders were given during past hurricanes to question why improvements along Tamiami Trail for hurricane evacuation alone would have justified the causeway. Instead, the situation remained for decades the most visible manifestation of the "no man's land" phenomenon. The Miccosukee tribe claimed that concerns about legal action were unfounded (Chief Billy and his staff, March 2006, personal communication), yet the Tribe did take legal action trying to prevent the Corps and the Interior Department from moving forward with bridging in 2008.

There was also the problem of the Corps entering into a real estate escrow agreement with the Florida DOT for the right to flow water under the existing Tamiami Trail (to account for improved flow resulting from replacing gated culverts with more passive weir-type structures) in lieu of raising the section of the road not within the alignment of the 3,000-ft bridge until the future CERP features were identified. Florida DOT opposed entering into the proposed real estate escrow agreement as it was of the opinion that this would constitute an unacceptable transfer of liability to the State agency.

The fact that U.S. 41 has not been elevated over the Everglades and stretches of the Big Cypress is puzzling. If the political will could be mustered to stop the Everglades Jetport from being built in the 1960–1970s by a coalition of south Florida leaders, what has stopped the emergence of leadership to conduct the flow-response experiments and elevate Tamiami Trail not just across Shark Slough but vital sloughs in the Big Cypress that were severed as well?

Lamar Johnson, the last director of the Everglades Drainage District, pleaded with the park and the Corps of Engineers during the C&SF project design and construction to attend to the overland flows across the Trail. He estimated that while 80% of the water in the park came in the form of rainfall, the 20% overland flow was vital to the health of the park; a national park that has been set aside specifically for its natural not recreational values. His warnings during the early 1950s were ignored (Light 1983).

In conclusion, there has never been the governance structure that combines public, private and non-profit interests to preside over the course of affairs along the park's northern frontier (Gunderson and Light 2006). Again, the schism between Interior committees in the House of Representatives and water and transportation committees in the Senate are partly culpable. The lack of an effective governance structure in South Florida is even more to the point. The lack of political and civic leadership and courage, given the successful campaign against the Jetport in the 1960s, seems inexcusable.

7.6 DECOMP/DAMP

In August 2005, the top CERP managers from the SFWMD, the Corps, Everglades National Park, and the Fish and Wildlife Service tasked the DECOMP team with developing a plan for a large-scale experiment; including budget, schedule, and recommended designs using an adaptive management approach. The approach to DAMP (<u>D</u>ECOMP <u>A</u>daptive <u>M</u>anagement <u>P</u>lan) was to learn how to design the departmentalization of the Water Conservation Areas (referred to as DECOMP) using scientific experimentation (i.e., <u>active</u> adaptive management).

DAMP development principally involved federal and state agency participants that integrated data mining and historical analysis into the experimentation and evaluation of the field study. The output of the experiment termed "physical model" was to propose the best design for implementing DECOMP without sacrificing system-level water supply or flood control capacity.

The challenges faced in developing DAMP were simultaneously scientific and political. The southeastern corner of WCA-3B was known to have serious seepage problems, so DAMP would have to assess the seepage potential and ways to address the system's vulnerability. The canal capacity in L-31 to shunt seepage water south and not impact ground water elevations in the North New River drainage basin was questioned. Interests of the residents east of the perimeter levee in the North New drainage basin needed to be considered as well. Even the perception of diminished flood protection would unnecessarily depress land and real estate values.

Levee modification was a concern not just to determine the ecological effects (i.e., hydrology, sediment, vegetation, and wildlife), but the impact on sports fishery-related boating. The real threat was not really access to the fishery; it was access by speed boats enthusiasts that relied on canal access – potential adverse long-term impacts of sales of speed boats brought manufacturers out of the woodwork. This is an example of restoration values being threatened by an economically profitable mode of fishing that was not even in existence 30 years ago becoming a major barrier. An argument could be made that speed boats are an incompatible use with future restoration intentions.

Levee modification effects on sheetflow, ridge and slough landscape structure and function, and Everglades' vegetation and wildlife raised legitimate scientific questions. However, from aerial inspection, it was evident that the volume of sand on the spoil piles created in the 1950s or earlier was not sufficient[14] to permit complete backfill without considerable quantities of material imported using expensive construction methods.

Therefore, DAMP would need to assess the biophysical effects of partial and "extensive" backfilling options. Politically, the backfilling option permitting the largest boat channel would result in more support for the plan from fishing and hunting interests. The consideration of alternative sports fishing experiences and their economic benefits to the area were never raised. The same interests had a stake in the tree islands that acted as refugia for deer that, during hunting season, were sure prey to the same cadre of motorized "sportsmen".

There were also cultural concerns, for the tree islands were tribal burial sites. As such, water depth and hydroperiod stresses on the vegetation and habitat of tree islands were problematic to the proposed field test. Unfortunately, the tree islands issue over the 6-month development of the experimental design became so political that final recommendations incorporated the need to maintain and/or restore tree islands regardless of what the hydrological determinants for restoring flows indicated. The necessity of artificially maintaining tree islands was not questioned (Fig. 13.10).

Finally, the benefits of sheetflow would have to be quantitatively supportable. DAMP would have to accomplish this task to satisfy Corps of Engineers and Office of Management and Budget cost-benefit requirements. This can be viewed as an example of how brutish and "efficiency-driven" means can dictate the qualitative "ends" of CERP's creed "Get the water right." Another interpretation less based on

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[14] The "bleach white" appearance of the spoil piles along the interior canals in Water Conservation Areas 3 A & B were evidence of the oxidized muck that once was part of the spoil excavations.

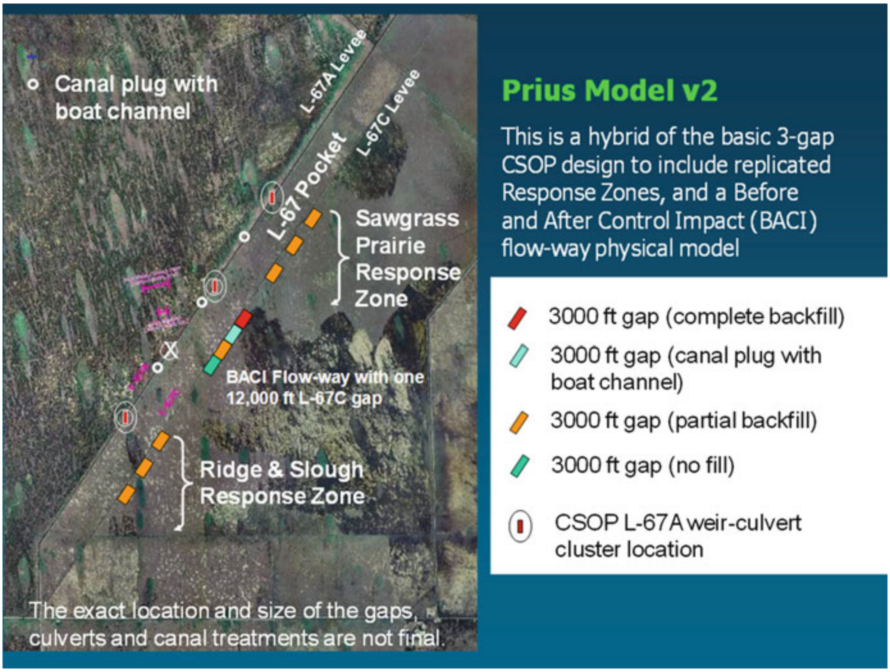

Fig. 13.10 The Prius design v2 to test alternative flow regimes across differing ecological communities in water conservation (Courtesy Fred Sklar, SFWMD)

an epistemological failure is that the particular methodological requirements by OMB for how cost-benefit analysis should be done were highly flawed. That is, it may not, per se, be cost-benefit analysis that is the culprit but insistence by OMB (and, sometimes, the Corps); on methods that many ecological economists view as unsound. The bounds of the experiment were initially set at an inexcusable "4 years and $10 M," given that the results of restoring the flow regime were the major environmental reason for CERP.

On the surface, this constraint would appear as one true measure of the combined institutional commitment to turn "unknowns" into "knowns" scientifically and a measure of how much political capital or risk policy makers were willing to take at the time. Out of an $8 billon commitment (now estimated at $12 billion), all that could be mustered for addressing the most challenging questions regarding flow and ecological restoration did not rate 1% of that total (Fig. 13.11).

7.7 Proposed Field Test (April, 2006)

By April 2006, the scientists and team leaders from the Corps, SFWMD, Everglades National Park and FWS had accomplished their task – the design of a field test costing

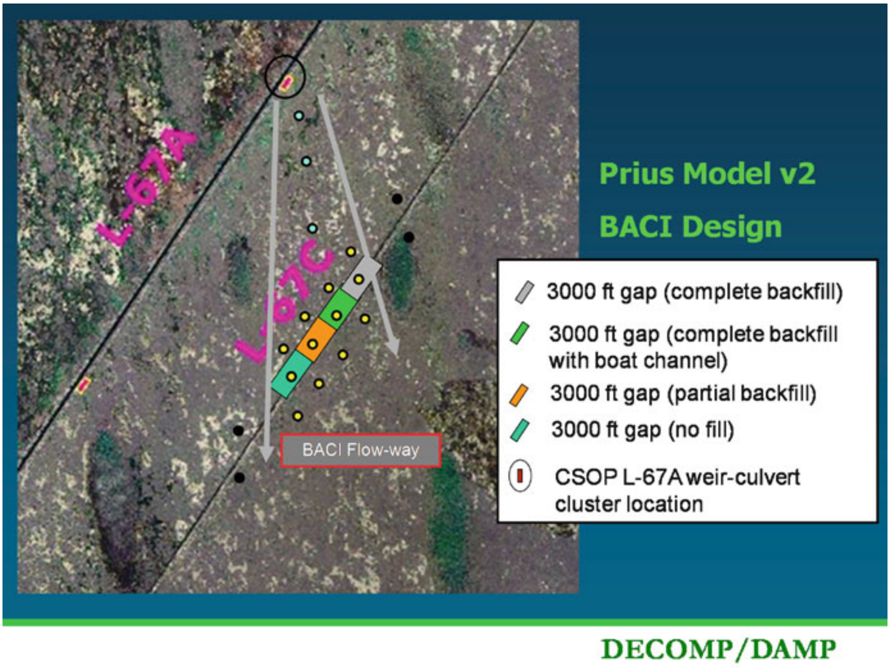

Fig. 13.11 The BACI design to test the impact of alternative flow regimes on differing canal degradation schemes (Courtesy Fred Sklar, SFWMD)

an estimated \$10.3 million over 5 years. The design was brilliantly conceived and involved two major components (Fig. 13.10): (1) Diversion of WCA-A water flows through weir-culvert gaps in L-67 A and C into 3-B that would allow high inflow rates and controlled, short-term hydraulics to test responses from the sawgrass prairie and the ridge and slough areas (2) Establishment of a flow-way in L-67 C connecting WCA-3A to 3B that would test for backfill options – complete backfill, backfill with boat channel, partial backfill, and no fill options.

Real leverage on the major uncertainties of the overall "Prius Model v2" test design featured maximum scientific rigor (3 replicates), optimum number of treatments and high inflow rates, and good control of short-term hydraulics. As fractious as the institutional environment and as burdensome as the rule-following behavior was, the DAMP design was elegant and masterfully orchestrated.

In April 2006, the Quality Review Board approved the DAMP design. Since then, the single most important action to restore flow to the southern Everglades (\$10 M/5-yr experiments) has been shelved. There has been a failure to launch, despite recent approval of a revised design. The original experimental design as approved in 2006 could have been nearing conclusion at this juncture. This policy failure to act can be attributed to a loss of political will and social response-ability by the agency leaders on the QRB, and the policy makers to whom the QRB reports.

8 From Imaginings to Ingenuity

8.1 Hamartic Wounds

The widespread retreat of the natural environment on all fronts in the Everglades, the failure of the best efforts of science to design a linchpin flow experiment for "getting the water right", the injustices that have been perpetrated on the migrant Haitians by the sugar industry, and the deprivations foisted on the Miccosukee and Seminole tribes,[15] all these are ***hamartic wounds***, or "injury through ignorance". These wounds have been chronicled, but we still, metaphorically, keep retrieving the corpses floating down the river without understanding the mounting nature of the challenges we face (e.g., human predicament), much less how to respond appropriately. The message as medium from dynamical systems thinking is for the "evolution of the evolutionary mechanism" – human nature. Integral to that change is the process of discovering ingenious ways of reconciling the relationships of humanity and nature.

H.T. Odum and Robert Costanza attempted in the 1970s to fashion an approach to restoration that broke with the mechanistic nightmare that is the C&SF project, striving to return to more passive means of water conveyance and control. Their ingenious approach which emphasized the importance of ecological and economic energy flows was prophetic and summarily ignored. With oil price peaking and climate change becoming more potent influences every day, the vision of south Florida will need to change. Making room for nature will require major adjustments in the form of land alteration and use, among other things.

The Dutch (*Ministry of Transport and Public Works and Water Management* 2000) have reversed their 400 year old philosophy of "control" and are now finding ways to let their "rivers roam." Their gains may be modest to date, but given the fact they inhabit completely altered land and waterscapes, their intent on change is authentic. One can now find advertisements in the newspapers soliciting for couples willing to occupy farms for restoring patches of nature.

The western states that have wheeled water over mountains and down long stretches of desert for well over a hundred years are changing their minds. As the director of Portland's regional water system noted, "For a century we have been moving water to where the people wanted to be. The time has come to start thinking of moving the people to where the water is." South Florida cannot support the doubling of its population every decade since WWII without inflicting irreparable harm to its natural environment and without suffering the consequences. Pursuing any regional "balance" between social and nature given the loss of stationarity is a myth. There are simply too many people in the region to ever balance the books with nature's needs.

[15] Please do not confuse the obfuscation of their culture and tribal lands with the substitution of "fire water" with the addition of gambling regardless of its monetary enticements.

8.2 Relationality

The subsequent section proposes an alternative approach of reasoning regarding how to evolve social reality in keeping with nature's developmental and evolutionary operating rules (Polanyi 1958) including the predominance of symbiosis, synergy, the search for excellence and the inherent "becoming with" of emergence. Immanuel Kant's *Critique of Pure Reason* (1788) was on the right track when he proposed "practical reason" based on his dissatisfaction with the European rationalists and the British empiricists – the epistemological underpinnings for how we structure decisions in modern society.

Both schools of thought strived to separate problem solving (reason) from our sensibilities. The passions (e.g., feelings, intuitions, sociability, and personal judgments) of humans were deemed untrustworthy and necessary to eliminate as a weakness in humans, who needed cool, dispassionate, and more calculated means at their disposal.

In our estimation, the subsequent advocates for empiricism and rationalism trivialized the differences between them. Kant, in his rejection of both schools of thought, advanced the notion that pure contemplation or pure observations alone were insufficient bases for reason. Kant argued that we can only obtain substantive knowledge of the world by exercising all our faculties – our sensibilities, our conjectures and theories, as well as our observations and understanding of experience.

Further, in Kant's *Critique,* science was also viewed as deeply dependent on the sensibilities and understanding of experience as the origin of concepts and principles upon which science must rely. In his mind, reason was the arbiter of scientific knowledge we have gained through the detection and correction of error and the achievement of more comprehensive insights into the nature of truth and reality. Reason as applied to science is to search for the greatest possible completeness, not the permanent parsing of reality into isolated elements. Kant's maxim for "regulating the principle of reason" in the search for knowledge as unity. Kant was an organicist.

Kant's concept of science forms the basis for the revolutionary organicist movement in developmental biology, which is shaking the foundations of conventional science as practiced for much of the past 100 years (Keller 2002; Haraway 2004; Gilbert 1998; Margulis and McMenamin 1993). Reductionist approaches to science that attempt to relegate all things to their physical and chemical components are being challenged by a new Kuhnian (Kuhn 1962) scientific revolution. Richard Dawkins' (Dawkins 1976, 1986) myths of "selfish gene" and "blind watchmaker" are crumbling before dynamical systems findings that emphasize the relational nature of natural selection as a process. It was never the "survival of the fittest" but the survival of the most "fecund" and not at the level of the individual but that of the population. Moreover, survival is based on reciprocal induction between parts and whole of the organism and between the organism and its environment – emergence in the pursuit of excellence in the form of the appropriate response to the fullness of the challenges faced.

What has only grudgingly emerged to date is Kant's notion that all observations begin with sensory perceptions of the encounters of organisms with their environment, which form the basis of cognition. Maturana and Varela (1992, 1980) have advanced this concept (see Capra 1996 for discussion of their "Santiago Theory of Cognition" and comparison with Bateson 1972, 1979). Instead of the one-sided search for chemical and physical constituents, science should be paying more attention to evolutionary convergence (McGhee 2007), the "Law of Growth" (Thompson 1942) and "crude sense of the whole" in reason (Gell-Mann 1994), and catastrophe theory (Thom 1975) inspired by Waddington's (1975) work on epigenetic landscapes in developmental biology.

As discussed above, more organismic approaches to reason, as a basis for judgment must employ concrescence. Like the continual emergence of complexity and spontaneously of life, concrescence is irreducible and never stationary. The essence of design in policy formation is an active openness and humble boldness of intent that "planning" and "incrementalism" cannot accommodate.

Eric Jantsch (1975) offered high praise to Ilya Prigogine, a dynamical systems theorist for "restoring purpose, meaning and hope – to life and human action." Prigogine, the Nobel Laureate who coined the phrase "order through fluctuation" emphasizing "the arrow of time", envisioned the dawn of a new rationality, one based on new understandings of man's relationship with nature and him/herself. We name this new form of reasoning as problem solving – ***relatonality*** (see Shults 2003 for philosophical treatment of subject) that recognizes all life is problem solving (Popper 1989) in which the fundamental unit of analysis is relationship (Haraway 2004).

8.3 The Relational Nature of Life

The vast majority of science is based on reductionism, the analysis of fragmented parts that ignores the rudimentary relational scaffolding of reality into composites of the "crude sense of the whole." Adherents of "null-hypothesis testing" reject as credible Bayesian methods that recognize the value of human experience and expertise in executing the scientific method (Hilborn and Mangel 1997). Reductionists favor precision and generalization of results over reality despite the overwhelming challenges of the human predicament. This is not to discredit the singular contributions of reductionists such as David Tilman (Tilman and Downing 1994) and Michael Rosenzweig (1971), whose incisive analytic contributions have helped clarify and expand our understanding of critical concepts in ecology; diversity and stability and the paradox of enrichment, respectively. It is the almost total disregard for the organismic nature of life that we find so objectionable.

In a highly contextual reality, the search is for the most fitting or appropriate response, not a single "fit" (e.g., attack of the one size fits all) that implies an unimpeachable, dominant position. Fitness landscapes are in the process of forming and deforming all the time (Kauffman 1995). In economic systems, the "best" or most "fit" solution is frequently surpassed by inferior solutions as "feed forward" mechanisms steer the direction of markets (Arthur 1994).

Much of water and land-related approaches to management in the literature now embrace adaptive management. Holling (1978) *Adaptive Environmental Assessment and Management (AM) is* cited in a perfunctory manner whenever the topic is introduced. Ironically, the popular cybernetic cycles of activity (variations on the "Plan, Do, Reflect Revise" found in Total Quality Management), the AM symbol of choice, is not found in Holling, ed. (1978). Most of the book is devoted to procedures for conducting integrated patch and system-level assessments drawing from a diversity of examples. Unfortunately, this procedure referred to as Adaptive Environmental Assessment (Light 2001a) has all but faded from existence, and in its place has sprouted "structured decision making" that has been used to determine such things as the most cost-effective means for providing habitat mitigation (referred to as "bird hotels") along the Missouri River – putting more parts in place methodologically ignorant of the larger scale river dynamics (Light 2009).

Synergistics, symbiosis, and mutualism speak to the relational nature of life, the fundamental "becoming with" of reality as an emergent process that require more scientific and policy attention (Prigogine 1980). The era of "scientific management" is on the wane, despite or because of its popularity. It is myopic (e.g., fisheries stock assessment) in focal awareness and attention, and unable to install a fundamental systems-centric approach to problem solving with nature. The use of adaptive management as featured in the proposed long-term experiments by the U.S. Geological Survey at the Glen Canyon Dam have turned technocratic, a growing irritant for the diverse interest-group advisory committee involved in the process. Personal conversations with management in the Bureau of Reclamation reveal this preoccupation with fisheries, flows, and shifts in sediment downstream of the dam, while a "blind spot" is apparent in the lack of balancing experimentation with larger-scale, systems-level assessments that include the social and economic issues.

Furthermore, in the larger practice of agency-driven and consultant-staffed water resources management, the scope of a project is the first casualty to "efficiency" in schedules and budgets. Second, "management" means the riveting of attention on a focal target, where the dynamics inherent in relationality invite more give and take in the course of affairs. Along a parallel line of thinking, small teams of scientists and lay experts of diverse backgrounds, and not a "manager as arbiter" have been found to have superior abilities in grasping the contextual nature of complex problems when compared to the understanding of solitary individuals. We refer to this as ***requisite diversity*** – the minimum variety of information and sensibilities necessary for capturing complexity.

8.4 Policy Design for Evolution

The image of man affects the nature of man. The twentieth century, besides being one marked by unprecedented breakthroughs in science and technology, was accompanied by the radical loss of certitude, predictability and regularity. It has also been one curiously preoccupied by the prevalence of means of "muddling through",

Fig. 13.12 Key tenets of South Florida restoration (Courtesy of John Ogden, SFWMD)

"disjointed incrementalism" and a paucity of ends reflected in the human vocation. As one director of area studies at the National Science Foundation put it: "I would be happy to fund studies on sustainability if someone would define it in operational terms for me." Ends like "sustainability" only exist in the eye of the beholder and fail to get at the heart of the matter. Fundamentally, we do not understand the nature of the problematique we face. ***The challenge is not sustainability but our capacity to evolve.*** Figure 13.11 Lists the Key Tenets of South Florida Restoration as articulated by the Science Sub-Group for the C&SF Project Restudy. The third tenet represents a sea change in thinking and action that has failed to materialize in the restoration but express the intent of Policy Design for Evolution (PDE) succinctly.

> The challenge is to understand the new system trajectories and guide them toward the goal of healthy and self-sustaining ecosystems.

The spontaneous workings of market transactions were intended to be the answer to the distribution of benefits and wealth in society; invisible means toward other elusive goals such as growth, progress, and prosperity. From this context, many economists (and philosophers) narrowed the functioning of markets to a "gospel of efficiency" rooted in utilitarian thought and the Enlightenment's pursuit of individual pleasure and happiness (as the right of every person), the basis for capitalism (Fig. 13.12).

Biologically, but in the same vein, Darwin's laws have experienced distortions through the work of Richard Dawkins (and others) who extended individualism by championing the "survival of the fittest", a product of social Darwinism, the capitalist in the extreme. Even some evolutionary biologists have accepted these individualistic premises. Ecologists offered up rather meekly that being able to "stay in the game," and "persistence in the face of adversity" can be viewed as criteria for success. C.P. Snow's two cultures (science and the sensibilities) seemed to have reached their logical extremes.

Have we totally forgotten the taproot of western thought – where humans fit into the grand unfolding of the universe, its meaning, and our role? Could biological systems offer meaningful metaphors for guiding human endeavors? Humans are not just a product of evolution but also an agent of evolution or in the words of the physicist Niels Bohr, we are 'both spectators and actors'. Yet, our images of man do not reflect this mantle of evolutionary agency with which man has been endowed. Why? Ironically, the science of man, the image of man, and the nature of man are all intertwined but pretend to operate separately.

Dynamical system thinking carries very different messages of how humans fit into the cosmic scheme of things and what our role is. Humanity is part and parcel of the process or flow of evolution. Whitehead realized that humans are the reinvention of the means of invention: ***agents in and of the evolutionary flow.*** Language has given humankind a new method of evolutionary participation, one far superior to natural selection; intelligence as the capacity to accelerate development of human potentialities, a mode of hereditary transmission manifest in cultural systems.

As Waddington puts it to us, we are the evolution of the evolutionary mechanism with the capacity to evolve more just societies as reflected in the evolution of common law, which, by the way, includes fundamental mechanisms for equitable allocations of water – riparian law. The nature of man has the potential to transcend the "getting by" of things, or the pursuit of some illusory "happiness" to imagine a new and better order; a commitment to flourishing of all life – the natural order of emergence and creation.

Evolutionary perspectives release humanity as captives of Newton's sleep, lost in our own imaginings, out of touch with reality. We do not realize the quintessential evolutionary imperative, the first principle of living in Waddington's view – organisms and their environments influence each other reciprocally. Humankind was brought into being by evolution in relationship to the external world. Our agency is intended to adhere to this "prime directive". To maintain a dialogue between humans and nature, humans have to mobilize responses that match the speed, scale and intricacies of the challenges presented by the world around us. This is the end – evolution as medium – that has been chosen for us. Many of us do not even recognize the enormity of such an undertaking, most will ignore its existence, possibly hoping for the Biblical rapture spoken of in Revelations to come.

Our destiny is in recasting the image of man in the nature of evolutionary reality. This is the law of requisite variety, the foundational principle of cybernetics that we have ignored, and failed to fully comprehend at our own undoing. This is not about mechanistic views of "control" and "regulation"; this is about a larger cybernetic calling to – response-ability. If we are not capable of mobilizing responses appropriate or fitting to the multidimensional and nuanced nature of the human predicament – it is game over. Either we overcome our lack of being future responsive or surrender our evolutionary trajectory to the fate of the trilobites, on the one score, and bacteria on the other (Waddington 1960).

8.5 Agents of Evolution

The image of humans as agents of evolution in emergent reality could be a game changer in the history of man, assuming there is still time left on the game clock. Our meaning as humans is manifest in our capacity to be integral to the unfolding of life – emergence. This entails the exercise of our powers of relationship – the capacity and openness to be affected by others in the process of influencing others in the flow of "becoming with." This will require nothing short of the equivalent of the Golden Age of Greece (Toynbee 1946): a fundamental recasting of our civilization that adheres to the dynamical properties of nature – living with and profiting from nature's stumbling, creative advance manifest in the first instance as limits, thresholds, and discontinuities. What we call natural hazards are, for the most part, the disturbance regimes through which nature renews itself.

In situations such as the Louisiana Gulf coast, the distinctiveness of disturbance regimes is not quite as clear cut. It could be argued that the loss of the natural defense system of ridges and sloughs through natural processes made the New Orleans levee system more vulnerable to storm surge. On the other hand, one could point to the domination of navigation creating a sloughing effect; propelling vital sediment destined for delta formation into the depths of the Gulf instead. Still a third perspective is that the Louisiana Delta has collapsed due to a category seven earthquake gone undetected due to the lack of formidable geological substrate.

Human reasoning as problem solving must now be projected onto the boundaries between order and chaos in the midst of value-laden conflicts and unpredictable events triggered by unseen biophysical interconnections. However, the search is not for mediocrity, compromise, "just getting by," or even for "he who gets the gold." The search is for excellence – the search for composite solutions (for patches that are largely self defined) that order, reconcile, and mutually reinforce 80–90% of the conflicts, while leaving sufficient phase space for working with the flux of perturbations and emergent properties embedded in the remaining constraints, uncertainties and divergences.

In addition, focal awareness is now centered on the fact that each step/action could be a breeding ground of Per Bak's avalanches, which have always been embodied in the human dilemma. We live life forward into radical uncertainty, acting as if we knew what we were doing. We act not fully cognizant that the cost of policy failure and the probability of failure are extraordinarily high, but the cost of not pursuing excellence is extinction.

The era of management, incrementalism, planning as if the future were given and project-centric decision making are over (Ludwig 2001). What is real can never be completely controlled, what is completely controlled can never be fully alive; therefore, control and certainty should never be sought as goals.

Evolution, the continual emergence of novelty, only gives way to excellence not as solitaries but in configurations of wholes. The suppression of emergence through means of unilateral control is doomed to failure by the emergent rules upon which nature operates. The gospel of efficiency (the supremacy of parts) is losing its followers. The remaining true believers are with great futility attempting to expand its reductionist epistemology into the realm of the irreducible. Life is always in the midst of lurching, or "stumbling forward" as Eric Jantsch would say, into radical uncertainty in the hope of becoming more future-responsive.

We name this new approach to problem solving – ***policy design for evolution***. Reasoning, in this framework, is problem solving for which the focal attention is on policy as governing relationships in the course of affairs. These relationships also require a subsidiary awareness of how intentions affect others. Design seeks harmony, beauty, and wholeness. These are not platitudes but the nature of crafting composite solutions.

Design is the application of deep craft and mastery, which, with its open search and iterations of reframing problems and solutions, may seem like an expensive and laborious process. In actuality, such evolutionary design is a far superior pathway to resolving conflict-laden, multi-causal problems. Such design contributes to higher quality, more enduring, and more ecological and economical solution life cycles.

Design moves beyond even "adaptation" (with its unspoken goal of "staying in the game"), which lacks evolutionary agency or responsibility of becoming future-responsive. Design starts with the end in mind, not just the feedback from experiments that are, in the end, yesterday's news. The social and ecological systems we confront are moving faster than we can comprehend. Heuristic methods that build on Polanyi's "know more than we can tell" (tacit dimension) are capable of yielding the sophisticated conjectures needed to tap the prospective mind of man. However, unwavering intention backed by total commitment and civic courage to confront radically uncertain futures inherent in the human predicament is imperative.

The design facilitator is in many ways a misfit, especially as viewed by the tradition of policy analysis because the problem is never fully visible (nature of extreme emergent complexity) as the solution becomes apparent. When the problem <u>is not being able to define the problem</u>, evolutionary driven design is the only hopeful pathway to excellence. The search for superior quality breaks the mold of tradeoffs along a Pareto frontier where my gain is your loss. Excellence seeks to counter the "attack of the one size fits all" by searching out solutions that meet authentic and subjective needs, not those that claim universality and objectivity.

Policy Design for Evolution relies on concrescence to penetrate the veils of forgetting and the unknown embodied in our encounters with relational reality. The prospective mind of humans is discovered in depths of experience plumbed by the sensibilities that run deeper than reason can follow – to the tacit dimension, sensed clues, gut feelings, and intuitions hidden in the tapestry of experience; the rich and highly contextual relationships out of which the future invariably emerges always in surprising ways.

8.6 Implications for the Everglades

This chapter from start to finish has been about flow as manifest in restoring the "river of grass," in the sense that our notion of reality is not concrete or certain, but where in the words of Heraclitus *"everything flows, nothing abides."* From the perspective of problem solving (reason), we shift from reducing problems to their elemental being to the search for superior quality in compositives not a plan that fragments and reduces our attention to over 60 separable but linked projects sequenced over four decades. Restoration starts with a total commitment to the intention of creating local patches robust to contingencies that surpass the image of simply sizing pieces for a static jigsaw puzzle.

Frankly, we have too many scientists, managers and policy makers chasing too many "parts." Less is more. Ecosystems are economical; when they become too overburdened they re-simplify diversity, functionality, and structure for the sake of renewed performance.

Ecological restoration is "getting the <u>flow regime</u> right." The Everglades has fallen victim to the Red Queen effect, requiring more and more resources to just stay where the Everglades are – the perpetual motion machine. Should anyone care to look, they will discover that every major advance in the Everglades has been carried forward by a committed few, who refused to be denied or deterred.

The Law of Requisite Variety (Ashby 1952, 1956, 1962), the seed of cybernetics, formed the basis for all the systems-based disciplines that have flourished since the end of WWII. All of their roots can be traced back to these cybernetic origins. Capacity to respond is based on the minimum not the maximum diversity, functionality, and structure to achieve performance. Excellence in the arts and sciences inevitably yields to the principle of Occam's razor. Gell-Mann, Crutchfield, and Arthur, among other dynamical systems thinkers, consider a model elegantly based on what can be left out of the design without diminishing the quality of relationships and performance. Frankly, the Everglades institutions have become so encumbered with "rules" and "self perpetuating behavior" as to make them totally incapable of visualizing the hydrologic continuum inherent in restoration.

Next, there is no unifying governance structure worthy of guiding relationships in the course of restoration affairs. The construction of a one-mile bridge on Tamiami Trail could be viewed as just an exercise in brinkmanship. Just more concrete because it is hard for politicians to put their names on the less tangible but more vital aspects of restoration – ***flow*** requires an inherently composite approaches to solutions born of sophisticated science-based conjectures of implausible but potential futures that diverge radically from the present. Science of restoration has become the pursuit of politics by other means. Pouring concrete when we are not really sure the right questions are being asked about Everglades flow is getting the cart before the horse, to put it gently.

It cannot be denied that the commitment to Everglades "restoration" in congressional legislation was stated in grand terms that smoothed over underlying differences in visions, values, goals, and expectations. For restoration, with or without flow knowledge, it is not clear that participants (public and private) have a sense of just what they mean by "restoration." In this sense, the term offers sufficient ambiguity politically so that all interests can fit under its canopy while advancing the their disparate agendas lacking any shared intention.

As humans working in the Everglades, freedom is discovered in our shared evolutionary capacity to respond and not in our will to power. Based on past behavior, we certainly did not ask for this mantle. Nonetheless, people have always been eager to be part of something momentous and more excellent that will bring forth the best in themselves not as solitaries but in participating in the process of creative advance with others.

Think of the Everglades as a garden. Gardeners may begin with intentions of bringing fresh produce to their kitchen tables, but studies and experience repeatedly show that the commitment to gardening eventually carries us away with the joy of participating in and watching life emerge. To the hard, cold, steely breath of the rationalist, this attention to the sensibilities is all hogwash. But why does our current generation so distrust and abhor authority, our government leaders, and bureaucracy in general. Is it not witness to an overwhelming desire for a return of human sensibilities in the leaders of our time that can truly inspire us?

There are Phi Beta Kappas eager to yield in apprenticeship to understanding nature's operating principles (e.g., natural and organic foods as a social and cultural movement) in the discovery of trajectories that revive nature while enhancing human livelihoods on the landscape. "Might makes right" is not one of nature's operating principles. As long as we put restoration last and ourselves (water supply and flood control) first, we will witness the continued demise of nature and our own undoing Branscomb et al. (1976).

No, this is not an overture to the opus Pollyanna. There is a need for balance. Unilateral power is ever present and potent but so must be the power of relationship if we would only learn of it. Unless we muster the personal, professional, and civic courage required to be affected by others (Mesle 2008), first without attempting to insulate ourselves or dominate them first, Solzhenitsyn is correct: civilization as we know it will not survive the twenty-first century.

Policy Design for Evolution (PDE) is not an appeal for idealism or dogmatism or a petition for some moral imperative. Nature is never about one thing; a solitary object is an impossibility in the cosmos. The meaning of any one thing only (Polanyi 1958) exists in relationship to others. PDE focuses awareness on nature's operating rules, the relational reality, and getting beneath the surface of our experience (cultural blind spot), which is becoming shallower by the day.

The major discoveries that set the SFWMD on a restoration trajectory were not made by computer geeks but by field biologists without the academic credentials now required after their names. Walt Dineen knew the Everglades (27 years) like the back of his hand. On many an occasion the first author would be sent from the board chambers to find Walt so he could render the equivalent of an environmental assessment impromptu without any props or notes – nothing short of mastery of his craft.

At its core, Policy Design for Evolution is the necessary recovery of our sensibilities to reasoning. It is our strategic, questing, illuminating intuition (clues, gut feelings, anticipatory gifts) that senses pathways amid the network of stresses and instructions embedded in the depths of highly contextual experience (Clark and Majone 1985). It is these developmental pathways at the conscious and subconscious level that propel the imagination toward previously unseen and missing solutions. Bringing these emergent and creative bursts of insight into the policy design process is the challenge that PDE presents. The formation of policy follows not just function but evolution, life's creative advance, as the medium.

PDE replaces the current quest for efficiency as "one size fits all" with questions such as "what kind of soap does the river want?" This new disposition does not negate the axioms of "a working river and a river that works" or "getting the water right." Policy design for evolution simply gives our intentions the full commitment and focuses our awareness and attention on the nature of ***flow in full.***

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Chapter 14
Framing Practice in an Uncertain Climate: Adaptation and Water Management in the Netherlands

Daniel Hogendoorn, David Laws, Dessie Lividikou, and Arthur Petersen

Abstract This article describes and analyzes the implications of uncertainty for the policy analysis and management practices likely to be affected by climate change. It examines these through an extended analysis of water management in the Netherlands. The analysis describes how practice-networks, formed to produce and implement technical assessments, deal with different forms of uncertainty. The analysis focuses on the network concerned with dike safety and demonstrates the manner in which institutional procedures black-box uncertainty and insulate it from critical scrutiny, even by the actors involved in constructing models and administering standards. This analysis is followed by an examination of the relationship between experts and citizens in water management, rooted in experience with large water management projects. This experience highlights both the need for, and the difficulties involved in, changing the relationship between professionals and stakeholders at the level of expectations and behavior. The conclusions suggest new roles for stakeholders in complex technical domains like water management and sketch some features of a new model of practice that engages to the challenge of working under the shadow of uncertainty cast by a changing climate.

Keywords Adaptation • Citizen participation • Climate change • Policy • Practice • Uncertainty • Water management

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1 Introduction

Controversy has been a persistent companion of climate change since it first became a topic of public discussion. As disputes among scientists and modelers have become more marginal, the addition of policy makers and popular commentators has sustained the controversy over what observed data means and how urgently a response is needed. At the core of these interactions is a question about whether or not climate science provides a rationale for action and a firm and clear foundation for the design of policy to effectively guide a response.

In this chapter, we focus not on the answers to this question, but on the question itself. In our view, it misses the mark on two counts. First, it assumes that science will provide a kind of certainty that can precisely guide the response to climate change. Second, it presumes that it will be possible to craft a policy design that can comprehensively steer action. From a policy action perspective, the expectation of certainty is misguided. What science provides might be better called articulate uncertainties. It can help us grasp the shadow that our changing climate casts over the future and provide a perspective from which we can reason about how to act in anticipation of this turbulent future. The expectation that policy rooted in science can create a comprehensive design for action neglects much of the history of implementation studies as well as efforts to rethink policy in an adaptive, learning, or deliberative framework. The congruence between practices of inquiry and practices of democracy highlights the significance of the relationship between action and its institutional, professional, and political context.

Herein, we explore what it would mean to begin to take these alternative interpretations seriously. We try to provide a picture of how understandings of climate get shape and meaning as they are mobilized in the practice contexts in which action is taken. These contexts, like the practices of water management that we discuss in the following sections, are not a transparent medium through which science-based understandings and policy goals get expressed in action. They are historically rooted, shaped by strategic behavior and institutional settings, and both enabled and limited by habits of thought and action. Adaptation and other responses to uncertainty will take shape as a reworking of these developed forms of knowing and acting.

We develop this perspective through an examination of a practice context in which there is a long history of actively managing the relationship between nature and human action. Water management will sit in the core of our response to the uncertainties created by a changing climate, especially in the Netherlands where managing water in order to live below sea level is a long-standing fact of life.

We can expect controversy to continue to be part of this process. The nature of the controversy is likely to shift, however, as new actors become involved and problems change. The move to local action, for example, will bring stakeholders into play whose views and concerns develop not out of a scientific or policy perspective, but out of historical experience and the practices of everyday life. Controversy can be expected as policy proposals are viewed from the perspective of local stakes and experience. The peculiar character of climate change – that effects become more uncertain as questions become more specific – means that policy action will develop where the shadow cast by uncertainty is particularly deep. Institutional differences will influence the ways this shadow is felt in the translation into practices like water management.

We begin our review and analysis of Dutch water management practice with a technical area: the management of dike safety. We show how, even in this very technical arena, policy action develops through a network of actors in which comprehensive understanding is a fiction. The varied and highly developed practices and relationships that constitute the competence of this system make it hard to achieve a comprehensive view of features like uncertainty management. The consideration of uncertainty at any one node in this network is unlikely to be carried along with decisions. It is more likely to be black-boxed, as the choices and commitments that policy demands are made. The overlapping relationships between practices in this network make it challenging to achieve a comprehensive view on the demands posed by climate change. At the same time, these relationships are the medium that reflection will ripple through as it takes hold.

We turn next to look at a group of practitioners who are involved in a large-scale project of planning for climate change in the Netherlands. We look at how these practitioners reflect on uncertainty from within the context of their prior work in water management and what kind of rethinking this prompts of the significance of involving stakeholders in planning and management and the respective roles that professionals and lay stakeholders might play in making choices in the design of interventions and in the ongoing management of water resources. The picture that emerges illustrates their efforts to maintain stability by keeping uncertainty at arms length and by marginalizing the implications for the role of local stakeholders in policy practice.

2 Managing Dike Safety[1]

We begin with a look at how dike safety is organized in the Netherlands. A considerable fraction of the Netherlands lies below sea level and three large rivers flow through its delta landscape into the North Sea. The Dutch thus need to live with water, and to that end have developed a remarkable variety of technologies, strategies, and institutions.

The current arrangements have direct roots in sixteenth century efforts to harness a system of windmills, dikes, and man-powered drainage-machines to create and sustain polders.

[1] 'There are a couple of large blocks in motion around this terrain. First, you have the knowledge institutes. And they will always say: "there is always a need for new knowledge and research", because they have picked up some new thing abroad and then you have the second block, the water-managers, and they have to *do* something with the knowledge, they actually have to improve the levees. And then the third block is the policy-people, and they continually want to change things.' – Jos, expert in the Delta-committee. This quote depicts what also emerged in doing research. Research was conducted loosely based on Actor-Network-Theory, for a description see Latour (2007).

The combination of technology and institutions has kept large tracts of land safe for inhabitants to plan and develop farmland, villages, and whole cities. Even earlier, the demands of managing water fostered the first bodies of local government, relying on forms of democratic cooperation among those who had a stake in keeping the land dry and the rivers and sea at bay. These Water Boards have been part of water management since the thirteenth century. This decentralized way of getting things done continues to influence the political system of the Netherlands (De Meij and Van der Vlies 2000).

As the available land has filled up with housing, businesses, and recreation, the stakes involved in water management have grown. Knowledge and practice have kept pace, however, and, notwithstanding some painful disasters (1993, 1994), the Netherlands is currently considered safer than ever. Knowledge for managing water and maintaining safety develops primarily through the action between highly specialized scientists and policy-makers. Afterwards, from what is known in this collaboration, these actors distill a (sometimes legally protected) commodity, for example in the form of a guideline, a graph or a computer-model. Such commodities are then transferred to so-called users, such as dike inspectors of the Water Boards. These users have little power, and tinkering with the product is constrained, even when the information in the commodity seems of little use for ordering the environment in which they work. As scientists and policymakers continue to ask new (though not necessarily better) questions, more information is packaged and shipped through these networks. The practices that make up water management are now extremely complex, and top-level civil servants need strategies to maintain control. The way water is currently managed in the Netherlands is sophisticated, but also entrenched and opaque, leading, at times, to a lack transparency and accountability, internally as well as with the public.

The complexity arises from a continuous search for new knowledge. Scientists and policy-makers continuously converse, and negotiate an agreement between new knowledge and new actors and the status quo. With new actors, values change, as well as the status of what is known. From one perspective, changing values and changing status of technical knowledge opens up knowledge-development and produces a wealth of insights that support forecasts on anything from hourly variations in the height and pressure of water to what kind of storms can be expected in the next 20,000 years. From another perspective, searching results in an impenetrable cloud of expertise that produces new uncertainties by continuously recombining and pruning expert knowledge. Like the polders, this system requires continuous commitment and effort to remain stable. Knowledge is pumped through to create a stable social performance of interacting practices. As with many complex systems, it is difficult for 'insiders' to get or sustain a perspective on how what they produce is tied to the way they practice and with whom.

The complex ecology of governance that ensures protection against water-nuisance and disasters includes many interacting functional networks. In the section that follows, we analyze the network that manages the development of hydraulic requirements and flood-risks. We analyze a series of interviews with actors from this network. These interviews focused on how action and change take shape within this highly developed technological-institutional system. Hydraulic requirements are established to keep dikes and water-breakers up to standards. Flood-risk assessments – to put it euphemistically – are set up in case they are not, or if the standards themselves were not realistic. Both hydraulic requirements and flood-risks illustrate how change happens in water-management. First, knowledge-developers update hydraulic requirements in routines run every 5 years (and in the future six). Knowledge is produced, implemented and questions and uncertainties are pumped back into the next round. Second, flood-risk assessments are currently being updated, since the overall philosophy that provides their foundation is outdated: it was conceived in the 1960s, and frames risks in the context of economic damage alone. But times have changed, with more people populating the more risk-prone areas, people see *themselves*, instead of their property, as the prime thing to protect. Prioritizing victims means that a lot more knowledge is needed, knowledge surrounded by a lot of uncertainty.

In the section below, we summarize the stories of nine practitioners who, together, provide a picture of how change develops within this system and how its members face and frame uncertainties. Here, policy-makers, knowledge-developers, and dike-inspectors recount working together in a loose network that resembles a supply chain. Their work ranges from the mathematical modelling of waves and subsoil conditions to policy efforts to create deadlines and merge knowledge with political goals to the work of dike-inspectors who lament the complexity of all the calculations and wonder why they cannot just watch the water rise with their own eyes. All of them reflect on how the interplay between policy, science, and practice shapes water-management. They illustrate the ongoing effort to meet all demands in a rolling negotiated consensus that constitutes the practical horizon of dike safety and is protected from contestation by law. Uncertainties in the knowledge then become a "guiding principle for action" that enables thought and action to progress.

The network through which this consensus is produced and sustained is traced by following the trail of connections from one respondent to the next. Each respondent provided other respondents, colleagues they worked with either 'upstream' or 'downstream'. The respondents themselves spoke of developers and users of knowledge, parsing science, policy, and proximal practice as distinct domains of activity.

Han works for Deltares, a private company that develops knowledge primarily for the Dutch government. Han helps develop hydraulic requirements. As a geo-engineer he has just replaced a hydraulic expert in this function, since enough was known 'about the wet sides of the dikes'. Han describes his work as "mostly desk research, developing models. There is some research in the water-tanks in the lab, but not so much." He describes how "content knowledge" is developed by reference to a project, Sterkte Belasting Waterkeringen (SBW).

> The SBW is really a knowledge project. There, knowledge is really developed empirically. And they receive questions about knowledge they have to develop, mainly from the WTI [Wettelijk Toetsings-Instrumentarium]. Questions such as: 'So what's the deal with local storm-related rising water-levels? But also questions that users have with implementing the knowledge, having experienced a knowledge-gap.

Such questions are fed back from practice into science, as a kind of systemic learning loop. Practitioners ask questions to the 'Helpdesk Water', an intermediate body that provides answers about what is known, but does not necessarily pick up what is unknown. Questions picked up from practice help to orient the research done by the SBW. This, for instance, is one way that Han receives new data to model. He cannot directly communicate this new model to practitioners, however. It must first pass through the hands of other actors who reshape the knowledge in light of competing priorities to bring 'form and process'.

> We do the project itself with the Waterdienst, and the project is assigned by DG Water, Rijkswaterstaat. The Waterdienst takes it up in collaboration with us, where we bring the *content*-component, and the Waterdienst look at form and process. That is our most important partner

Some look at the 'facts', others guide these facts towards application. Being the most important partner, there is some special solidarity. Han continues:

> I see it as follows: On the one hand there is production, the collaboration between Waterdienst and Deltares, and between them there is weekly contact over what little things are currently issues, and how to respond to them. There is a very intimate contact.

The intimate contact results in a form of consensus over what is going on. Yet, since this knowledge needs to be applied in a broader group that is not part of this solidarity – 'the users, the Water Boards, and, somewhat further down the line, the engineering bureaus' – Han emphasizes that there are checks and balances in place that increase the probability that a broader consensus on knowledge develops.

> There are the Expertise Network Waterveiligheid, the Sounding Board Groups, the Watersystem-groups, consisting of Water Boards and Provinces.' […] 'Then the DG Water has a Quality-group, or in any case a group that guards the quality of the whole project.

The Expertise Network Water-security (ENW), an elite group of experts, is present in multiple groups and gives its opinion about Deltares' findings to DG Water, and other government actors. When the Waterdienst and Deltares have come to a consensus, the knowledge gets picked up by one of the theme-based groups within the expert-network, most of them based in Technical Universities. This creates a 'filter' that minimizes the chance and the impact of bias. Han and his Waterdienst counterpart approach the ENW, and say: 'so what do you think of this? What is your opinion?'

In practice, such bias-reducing activity generates its own problems. Developing knowledge is a social affair, not a game of solitaire. And, as with any social affair, contestation is as much a part of interaction as collaboration. ENW also has an agenda that they, along with others, bring to the process of harmonization through which knowledge is negotiated on the basis of interests (literally):

> They [the ENW-experts] fill in the programme on the basis of the pool of questions that arise. And this is a game that is played with a lot of other players. [We] have an influence, and of course we officially ask the question, but there are a lot of other factors that have an influence on what kind of knowledge is being developed.'… 'In every process there are the 'knowledge-people', and those knowledge people have their own agenda. That [agenda-point] doesn't really have to be a real question, but is often a 'hobby', something they are interested in, or just already know a lot about […] People try to influence the process in all kinds of ways to make sure that those things are researched.

On the basis of data collected by an SBW-machine programmed to see specified things, Han first tries to fit everything he obtains into a mathematical model that he hopes will be workable downstream for practitioners. Yet, as knowledge progresses through the supply-chain, it changes, but does not always become more accurate. For example, after Han's careful calculations are filtered by the ENW, they reach policy-makers, who value time and practicability at least as much as accuracy. As far as the policy-maker is concerned, for deadlines to be met, produced knowledge must be consistent with what they already work with. In the meetings with policy-makers of the Water Dienst and the control group of experts at the ENW, new negotiations start – but policy-makers call the shots. They control the agenda and the deadlines within which consensus must be reached. For policy,

> [i]t is a habit to not keep the [statistical] uncertainties, but just count them as averages. But the reflection-group at the Expertise Netwerk Waterveiligheid, always contests this process in every discussion. They say you have to include the uncertainties. From this scientific perspective, it is said: yes, you have to include it because it is a piece of data. And every time the Waterdienst [policy] says: yes, but we want to be consistent [with prior practice/other documents]. Then there are two different tastes, and these collide.

In the end, 'the WTI-project usually notes that "it is important",' for some 'policy-related argumentation over [the discussion], and takes a note that it will have to be picked up by the SBW for the next round.'

Actors strive to avoid endless contestation and stabilize knowledge. Without some consensus on what things mean, action can't be undertaken. Han calls this 'securing'. This is a term that is often used by respondents in various contexts, from minute technical details to policy-making for the whole of water management. Knowledge and policy are 'secured' by agreements, by making it a formally rubberstamped model, by laws such as the water act and guidelines that are tied to European rules. Han explains:

> Priorities say: what am I going to do, and what am I not going to do? When you have secured the project, it becomes harder to not do something, or do something else. […] If the question persists, you have to go through the whole circus again, and thus this often does not happen. Another possibility is that you start doing things that you had not thought of before. [In a project that has been already decided upon] this does not happen very often. *This is, I think, the most important thing: once the norms have been secured, these things provide less of a nuisance.* Sometimes [water-managing] users don't know how to do something: 'what should we do?', and then we have to say: we don't know, we don't have the knowledge: it is not part of a hobby, not of planners and not of researchers. Then 'priorities' push out those questions (emphasis added)

Alessandra works for the Water Service and sets up testing-instruments for 'users' in the institutionalized 5-year cycle of hydraulic requirements. She combines the knowledge-consensus produced by Deltares and the Expertise Network Water-security with policy demands that she helps to create. The combinations she produces are put in a black box that is protected by a national law.

> In the [policy] instrument, uncertainty is [embedded] in models and in the law. It [uncertainty] is based on the knowledge that counts as such on that moment. Once the instrument exists, the water-manager has to test it *as such*. It's the law, actually. The uncertainty is built into this law, as an [institutional] fact reflecting the current state of affairs. All discussion has to

> take place during the setting up of the knowledge and the instrument, but once we call it an instrument, it can only be applied.

This does not mean that practitioners just execute, just that it is hard for them to deviate, and when they do, science takes over: "They can choose to deviate from the instrument but it has to be very-well argued, for … new tests are brought in, from rough to advanced. An advanced test is, per definition, not defined: an expert is called and will look at the situation."

The process Han and Alessandra describe around the hydraulic requirements is one with relatively little uncertainty – most of what there is lies within models, not 'out there'. The process is 'myopic', focusing on what is right in front of it (with an extreme sharpness). Disconnected from other issues, it is not of much interest to those who are not directly involved. Centuries of trial-and-error learning in maintaining dikes have created an accumulated body of working knowledge. Practitioners act from within this context with confidence that it is unlikely to suddenly become misleading or unworkable. This tool of policy and science operates with tremendous internal precision.

More fundamental forms of uncertainty are primarily present before knowledge begins to be blackboxed through interactions in the management system. As long as the practitioners from ENW, Deltares and the Waterdienst are negotiating, the outcome of the discussions remains open. Uncertainty enters these discussions when it is posed by people, so the best way to keep the uncertainty manageable is to limit who can join the discussion. Sometimes, Alessandra notes, it is not possible to black-box uncertainty, however.

> It is very important for us to know when we change the instrument that we are not only basing this on *content-knowledge*, but also on the fact that knowledge is shared and is valued; in other words, if there is enough legitimate support, if it is legitimately shared. And even when the instrument is ready, there is still an effect analysis. Only when everything is known [sic!] – what will the effects be? – then the DG Water [a high level government body] takes a decision to make adaptations to the instrument or not. That is a sort of policy choice to say in that area – a special area – the Hydraulic Requirements are kept stable for a while, until it is known how the whole area works.

Changing an instrument can create the need to take steps like widening a river or heightening a dike, the kind of steps that are likely to arouse controversy. Once controversy opens, even law and expertise will have difficulty shielding knowledge from contestation. Notwithstanding such temporary interruptions, the practice of setting up and maintaining hydraulic requirements is a relatively routine performance. It can execute self-sustaining functions with a reasonably degree of certainty.

2.1 *Increased Complexity: Climate Change, Victims and Flood-Risks*

Changing circumstances can disrupt the habits through which scientific beliefs are attained – not by changing the methods employed, but by changing who is involved. New actors appear, bringing with them new 'insights', that do not only critique the Hydraulic Requirements (HR) as it stands (such as highlighting the importance of wave-length relative to water-pressure, or propose a tenfold increase in protection-levels), but can also shift perspectives when 'clubs' of civil servants, scientists, and politicians debate new ways of seeing what counts as important. Mathijs, a policy-maker and colleague of Alessandra works to link the HR with the clubs that debate new points of view.

> The State develops the methodology and the security-philosophy, being the only club with the power to do so. […] There is now an increased focus on victims, and climate models, instead of economic damage alone. The intention is to keep this stable until 2050. […] it will cause considerable *fuss* to change [the philosophy]. How are you going to divide the pain? Or tell [people] that one part will just be safer then another? You want to settle such discussions for *a long time.* [Knowledge]-Users are victims, so to speak, of what we decide to scatter over them.*'*

This 'club' – the interacting group of actors that Mathijs views as the embodiment of 'The State', went on to form new clubs – such as the Delta Commission – as members realized that many of the standards and commitments underlying contemporary knowledge dated from the 1960s – despite the fact that circumstances had changed radically and a body of new data was available. On the one hand, the increase in population had led to an increase in invested capital in the risk-prone areas. On the other hand, victim-avoidance as a top priority had gained traction. Thus numerous new actors contributed to reframing policy from an exclusive reliance on terms like protection to risk and sustainability, and from an exclusive focus on economic damage to victim-avoidance. The focus has broadened from questions about how to keep water out to protect valuable assets to questions about how to adapt to the fact that the water cannot be kept out.[2] With this shift, the neat world of the Hydraulic Requirements looses ground to the ethically[3] and scientifically messy world of calculating real flood risks and avoiding victims. Here all possible fault mechanisms of flood defenses and subsequent consequences of flooding must be included in the calculations. New actors offer themselves (or are attracted), bringing new insights to help calculate the risks of the resulting complexity, a complexity that is largely based on the 'simple' decision to include victim-avoidance as a significant value. Although it is dubious in itself to think such risks can be fully calculated, this example of a continuous influx of new actors and new insights introduces a far more radical form of uncertainty. This is so, because as these actors and insights become enrolled in the existing system of water-management, the future becomes less determinate.

To reach consensus, the scientists and policy-makers involved must connect what they feel *is* certain, with something that *ought* to be done. As problematic and in need of accountability as this is in itself, it is even more troublesome when there is

[2]Also here a cost-benefit analysis is applied. One makes sure that really valuable assets are not at risk, of course. So one can accept for instance flooding of the lowest few tens of cm of a couple of houses, and take the damage into account when doing the total (economic) assessment. Social cost-benefit analysis remains an important instrument in the Delta Program.

[3]For example, 'How many victims do you find acceptable?' is a question that needs an answer before risks can be calculated.

no stable *is* to provide the basis for the move to *ought*. Knowledge-streams in Dutch water-management are heavily intertwined, so what is, for example, known about flood-risks frequently becomes mixed with climate science, or entrenched technical knowledge, such as the Hydraulic Requirements, because they are handled by the same, or cooperating, people who share facilities. In addition, people negotiate knowledge without direct experience and with little direct observation, making it hard to test arguments against reality.[4] What is known and used is thus the product of negotiations between shifting casts of actors as much as the influence of empirical of reality. In the negotiations of Dutch knowledge-development, these actors increasingly tie together the uncertainties of climate science with those associated with flood-risks and flood-protection. The content of what is negotiated keeps changing as new actors join in. Reflecting in and on practice might seem necessary, but in such circumstances is difficult because the dust rarely settles yet. In any case, the relevant practice is still being made. For instance, the meaning of climate change on a local scale is not known, and cannot be known right now. As the ENW-spokesperson Ilka put it: 'Not one millimeter of [accelerated] sea-level rise has been measured in The Netherlands. There is no change in trends'.[5]

Jos is a long-term collaborator with Mathijs on the HR, and is now a science advisor in one of the climate change 'clubs'. He explains how technical facts get extended in models to forecast how the things that are valued, like human life, may be affected and, in light of these projections, to reflect on the practice norms that shape features of dike safety:

> If you start to include victims, you need to construct victim-risks with complicated calculations that come from fine-meshed computer-models [that calculate at a scale of] of one hundred by one hundred meters. In those calculations it is assumed that if a breach takes place in a certain place, water will intrude through the *polder*. You start to see that there are places where the water reaches high speeds, where the water will be deep, or where it will rise very fast, and you start to see where most people will die. Near the dike, water will form a crushing vortex. Houses will not be able to resist that and will collapse. You need new norms there, ensuring stronger and thicker walls. […] In other places, further into the polder, where the water is slower, it is important to know how high the water will come: do you go to the first floor, or the roof? […] Evacuation becomes an issue. And then you need to know: how many people have to leave the area, how fast will the area flood. Then traffic-models are needed to calculate how much time you need to have inhabitants moved out by busses or their own vehicles.

[4]Influence in these negotiations is based mainly on reputation (e.g., 'Our scenarios are based on the IPCC report' – in turn based, at least partly, on non-hypothetical and non-extrapolated data) and forecasting 'what-if?'-scenarios that are hardly rock solid science. The value of scenarios is not so much what they say about the future, but the way they articulate the shadows cast by uncertainty and ignorance.

[5]See: http://www.compendiumvoordeleefomgeving.nl/indicatoren/nl0229-Zeespiegelstand-Nederland.html?i=9-54. There has been an unchanging upward trend, 1.8 ± 0.2 mm per year, over the past century. The issue is: it is not accelerating (yet), as when would expect under increased greenhouse-gas conditions.

Herman, working on flood risks at Deltares, reflects on the reasoning this involves:

> What is the foundation [of the water management philosophy]? People say victims. All right, but calculating victim-risks is a tough question. Indicators of mortality[6] are deduced from empirical examples that arose in the aftermath of the storm surge disaster of 1953. And things have changed. Communication has of course changed. A lot of things are different. When these things keep changing, then insights on and between indicators of flooding, water-levels and people becoming victims is very, very difficult terrain. […]

If knowledge cannot be stably ordered because so much that is important remains unknown or because the entry of new actors increases the range of legitimate perspectives, ordering people can create a provisional basis for stability. For the current regime, 'keeping things stable until 2050', as Mathijs put it, is a central goal. Stability implies, in practical terms, creating a system of practice that is sufficiently integrated to be controlled and to sustain itself. The capacity to declare things about the unknown is central to the role that policy and science play in composing this stability.

Herman captures the strength that this push for comprehensiveness has created and the interdependence that it creates:

> The power [of the system] is also that it is a system that holds for the whole of the Netherlands. It is not the case that every area has its own rules and norms, or can just make up its mind on its own about what is good or bad. These are stable prescriptions.

Stabilizing these forecasts, and the policy prescriptions that flow from them, plays an important role in the politics of keeping water management a priority and securing the one billion Euros annually that estimates suggest will be needed for planning, management, and physical interventions over the next 40 years. Jos emphasizes the degree to which politics both complicates and facilitates the task of maintaining this planning horizon:

> Then there is uncertainty in politics: who will be in power in the next 40 years? Our 'trick', if I may call it that, is the new Delta Act. The Delta Act consists of a Delta Program, and within that program a lot of measures are listed to ensure that we can attain the security norms in the future. And this is a plain list: for these and these areas, in this and this period, these and these measures have to be taken and implemented. The other section of the Act says that the money that is needed for these measures should come from a fund of one billion [Euros] a year. And then the Act says that provinces and water-boards have to work in correspondence with each other and under supervision of the Delta Program Commissioner, who reports to the Council of Ministers when something is lacking. Of course, we cannot fully prevent the possibility that in the future there will be other priorities, but *at least we have a law*. If you want to change that, well, you will need to have a very difficult, tough conversation, to say the least.

As important as these long term commitments are, they carry the distinct risk of also locking-in the perspectives and assumptions that are active at the moment without a sense of where they will become dated and when.

[6]For example: How high does the water come? How fast does it get there? If there are people, will there be victims and how many?

> We are fighting, in a sense, a war' [...] 'Water management is still fighting the last war. These are norms and situations of 1960 we're talking about, and we're *still* trying to reach those objectives. In the sixties, norms reflected the population and invested capital of that time. They looked at, 'What economic damage can a large flood do?' Norms for water security and the maintenance of levees and dikes [such as the HR] are derived from this. In the mean time, the population and invested capital have grown tremendously. If there is damage, it will be much greater now. When fighting the last war, the conclusion was: 'you shouldn't do that'. It's better to ask yourself the question: 'what do we need to respond to in the future?' Then you have enough time to prepare. That is why the new norms that we are working on now are set for 2050, so that we've got the time to reach our goal. This takes into account expected climate change – sea-level rise and increase of river-water – expected change in economic growth and population. That is the Delta Program.

Despite the strong drive for long term commitments based in comprehensive knowledge, the commitments cannot do away with the need for political judgments in water management. They remain in play in the most technical aspects of the process.

> [B]ehind seemingly basic questions – what is the chance that somebody will die in a flood – you have tremendously difficult calculations, and you need to *make a lot of choices*. What kind of information do you take with you? Those people at Deltares have all these models, but my question is: what are you going to put in? (Jos)

The answer at Deltares and other venues for choice is to enroll more actors until some combination of dialogue, debate, and negotiation produce a consensus that is stable because of the extended process of validation. At the same time, there is an ongoing effort to keep knowledge and judgment distinct. Cees, head of the climate department at Deltares, reflects on how this separation was organized in the second Delta Committee (Veerman Committee), set up in 2007 to assess the needs for adaptation to climate change.

> Feedback [on what happens with our knowledge] was very visible in the advice of the Veerman Committee, the origin of the Delta Program. More than half of the knowledge and advice had its origin in Deltares. We see [our knowledge] reflected back in a number of places. But we give advice from a knowledge-position, we don't make the decisions. So, once we deliver, policy-makers can attach a lot of other interests, and therefore come to a different conclusion.

The political process that follows puts a 'rubber stamp' on, and a black box around, the knowledge, uncertainty, and related judgements that go into the advice.

> This is . . . the process that precedes [the issuing of the report]. Deltares might have delivered the knowledge, but the Committee wrote the advice – not Deltares – and they deliberated and thought it necessary to air it in a way that was politically responsible and communicable to the outside world. And they did this to the Tweede Kamer (Second Chamber or House of Commons). And they did this to the Minister. And in that way the whole thing got rubber stamped.

This sequencing limits the degree to which knowledge can be renegotiated in response to the 'backtalk' that develops around action. Practitioners are not formally qualified to alter the knowledge-based structures created upstream. This remains the domain of knowledge-development institutes like Deltares. Practitioners are also largely unable to contest underlying values that shape the sense of where things have to change and where they can remain stable. Such judgments remain the prerogative of policy. The dike-inspectors have to implement the developed knowledge, but they have little opportunity to influence or change it.

> The state sets the norms, and they are published as a new Act. It gets sent to us. Usually just digitally. Most things are routed now via the Helpdesk Water.' … 'My daily work mainly consists of carrying out [what is] set by the state. They are imposed by the state. We also have guidelines, and these guidelines are entrenched in technical reports. Usually these are the same technical reports that were used in the designs.'… 'if they are ENW or its predecessor TRW guidelines, then we absolutely must look at them. These guidelines provide direction, but you need a very good story to deviate from them, because these are large studies. An ENW-stamp gives it a high status. So it is not very free. (Sanne, dike-inspector)

The free space that is theoretically left has to do with climate change, because this topic is so new that no consensus has arrived to found uniform policy upon. Yet, just because the freedom is there, does not mean it is acted upon.

> Free room is given for a robustness test. Climate scenarios. You execute a policy based on a particular climate scenario. The climate scenario is translated into the designs, I mean the designs for new dikes. The climate surtax. The State mainly uses a middle scenario, but locally you could deviate. Although I've never experienced this happening. But in theory, it could happen. Our basis is the Rivers guideline.
>
> Sander, another dike-inspector in an area with many rivers,
>
> We really have the feeling we just have to execute something and this is not a big problem. A lot of assumptions […] are continually changing, making dikes sometimes higher, sometimes lower, and sometimes somewhat less broad. We just follow the State on what it thinks critical water levels should be. Oh, we have an opinion. But no influence to speak of, because the state pays for the strengthening of the dike. The one who pays also decides what the pressures on a dike are.

Despite the substantial efforts to base policy and standards in research aimed at comprehensive knowledge, the need for the local practitioners who work on the ground to make judgments and adapt upstream choices and commitments remains.

> I think it is very good to do more, and more specific, research. But, you know what happens? For example, we had designed a new dike, but during the implementation problems arose, the subsoil was very weak, and it was very difficult to work there. A new mechanism played a role here, 'inflation' [opdrijven], and we didn't account for that in the design. So we needed more detailed calculations, and subsequently two years of calculations went by, and our conclusion was that the dike just would not do. Then [outside-expert] calculations started with all these *new* additional measures to calculate the strength of a dike, also to see if new insights could be assembled for them, and it finally turned out that the conclusion was that the dike just *still* would not do. So you have a problem in the subsoil, and you don't know how it behaves, and you yourself conclude that the dike will not do, and you then assemble all the brains to make sure that it is not adequate, and they affirm your conclusion. There really is peasant logic [boeren logica] at the bottom of it here, and that should be allowed to prevail more often over all these incredibly detailed calculations. (Sander, Water Board Dike Inspector)

Moreover, only when people begin to act on the commitments embedded in the standards guiding the construction of dikes, will the implications and significance become clear. Those responsible for testing the safety will be required to adjust testing procedures when, with changing goals and commitments, variations develop.

It matters how people experience a dike. There was a movement that liked slim dikes with steep slopes, and disliked broad dikes with a less steep slope. But these kinds of preferences make the dike less safe. There was a lot of attention to values concerning nature, and housing. So the dike was allowed very little space, and was designed to be the bare minimum [in safety] Now, I have to test this, and it's far harder – also because of interpretations and assumptions that are far more complex then in a design of 1981, which was drawn, so to speak, on the back of a cigarette packet. By the way, such designs, if you're talking water levels, still standing rock solid. Now the degree of difficulty and effort is such that I cannot make a realistic assessment by myself. And we need constant renewed affirmation that the dike functions

A similar process develops when technical standards change.

You need to recognize that for us to actually act on and implement new insights, we have to redo the whole design [of a dike]. We collect data on the subsoil, and together with your other data you form an image, together with the designer. And you interpret that image. Given all our uncertainties, and safety-margins, that dike ought to be sufficient. Then a new model or insight comes along. And now the whole process of interpreting the assembled data within the model needs to be done again. And the problem is that a lot of the steps undertaken were reported, but often the interpretation that the designer gave to it, is lacking in the report. And that interpretation is often a very, very uncertain but very important factor in assumptions. […]The more complex you make a model the harder it is to understand afterwards what the intention of the design was. The whole thing becomes a black box. […] I mean, if we get high water, I would make a call to Hungary: send us some people, because you still know how to put a sandbag in place. We have no experience with that.

It is appreciated in a global sense, that the 'front-line'-practitioners' experience and work matters.

Don't get me wrong, we are safer than ever in the Netherlands. […]This is the whole point: [in operations] we work with a system of dike managers, and these guys work only in practice. They look outside, and see what happens. And they often know better what is happening, at least in broad terms, then someone sitting behind a desk trying to reach conclusions with a lot of research data and interpretations and calculations. So if I leave, and we all decide to not calculate a single thing in the Netherlands anymore, then there will still be voices that will say: 'hey, it's getting critical here, we need to do something." It will just mean that the argumentation is not prefabricated to serve everyone. So you need the technique as a foundation to convince others of our field experience.'… 'Before the 1953 disaster they did not have a supercomputer to back it up with graphs, so nothing was done. Now, the problem is that people will listen, but that the complexity of all the models, insights and uncertainties is such that it is just more difficult to understand what you are listening to.' … 'In other words, more and more uncertainties are defined to reach a more optimal solution, a solution that, more or less, can be arrived at with common sense.

Scientists are increasingly insulated from this kind of direct observation and experience – as Han described, research is 'mostly deskwork'. This moves away from the practical context that historically, and up to fairly recently, played an important role in setting standards and goals.

In the sixties, for the Delta Works, a huge amount of experiments were conducted, and a lot of things were explored in practice first. But what you see now is that this practice-derived knowledge is too expensive to develop. Moreover, the insights that do surface are not discussed outside the organization within a broader context, but just in the ENW, which is a network but not a broader context […] What you get is […] some degree of 'hobby-ing'. And there are things that are invented that just make no practical sense. Or they are just not true…well, not true is maybe too strong…but it does not connect to the experience that we have… (Sander)

Here we see the implications of the developments that have occurred through the repeated performance of water-management in the Netherlands. The highly developed character of the network is essential for maintaining this high level of performance. It reflects a sense of stability rooted in the 1960s context from which it has developed. This path has placed a premium on a partnership between authoritative knowledge, that itself requires a balancing, and high-level politics. The judgment of practitioners and politics of implementation have been crowded to the margins by the commitments that ground and shape the network of relationships and interaction that constitute the competence of the system.

We can admire the intricacy of this system and the level at which it is currently able to perform. From the perspective of climate change, however, we can also see the vulnerabilities of this system. Substantive commitments are lumpy and being planned on a time scale of 40 years. The organization of the network itself expresses a view of the relationship between knowledge and action that may be suited to a stable environment, but whose ability to perform in a changing environment is less certain. The role of judgment is limited by the coupling of knowledge and authority. Front-line practitioners continue to make judgments, but they do so around circumscribed questions and with license that is marginal at best. The detailed observations that they make of the water system – the kind that might catch surprises in performance – have a limited impact. Learning starts at, and flows from, the top and it increasingly develops in isolation from the detailed practical experience that has historically been important. Knowledge is vetted, but in circles that mostly exclude practical experience, and it is filtered through political judgments and negotiations before its practical implications can be tested. The sheer complexity of these negotiations and the number of commitments involved make a renegotiation of knowledge difficult.

The view that we presented here is not available at any single point in the system. It is a compound image, made from the reflections of actors in a network that were elicited by the process of research. Together, these practitioners were able to render the system that they are part of in terms that open it up to reflection. They recognize important features of the system, like the black-boxing of uncertainty, but such observations rarely feed back into the system itself. The organization of relationships and interactions does not provide for such reflection, extend it, or make it available to others. It is something that practitioners engage in small off-line moments or through the intervention of a researcher. Such reflection is not part of the "espoused theory" of how the system operates. This view is sustained even when experiences of negotiation and judgment that are at odds with it occur regularly.

To better grasp the challenges involved in opening and organizing such reflection in the system we now turn to an analysis of the practitioners who were asked to reflect on the significance of changes in the character and degree of uncertainty in their work. These practitioners were all involved in a large-scale project for climate-related planning around the inland sea called the Ijsselmeer. In their reflections, however, they draw on a much broader history of projects in which they were personally involved and that raised related issues about uncertainty and the relationship between technical planning and the public.

3 Breaking with Conventional Practice Under a Shadow of Uncertainty

The uncertainties posed by climate change are prompting practitioners to ask themselves whether their conventional way of working still is suitable. Daniel, a policy practitioner who works for the Delta Program IJsselmeer area (DPIJ) organization demonstrates the kind of doubt that creeps in as the shadow of uncertainty deepens:

> We are so used to picking up a task like we have done every day, with normal projects where the shovel hits the ground in three years. In such cases it is easy to see whether your interest is served or threatened. That is how everyone, me too, approaches such a task. You have to come loose from that first. […] Here [in the Delta Program IJsselmeer area] it concerns 2100, who cares, what is then going to be a smart strategy? Is an increase of the groundwater level bad? Agriculture would say it is terrible. But maybe in 50 years we will have other ways of food production and we [might] eat more fish than potatoes. [..] I have no idea. (Daniel, DPIJ)

Kate, who works as a water advisor at a *waterschap* shares the feeling that climate change adaptation poses new, challenging demands:

> Perhaps the special thing is that you [as a practitioner] have to work with it such a long time in advance. Normally you would not act until another disaster [in water management] occurs, but now you act in advance. That is, I think, against human nature; especially, when it concerns making investments [as a governmental organization]. (Kate, water board)

These two stories suggest the need for adjustments felt by water management practitioners who feel the shadow of climate change. The demands that this generates for new ways of thinking and anticipating the future are perceived by Kate to run against human nature. Such 'doubt' is a central feature of the turn to reflect on practice and acknowledge that new challenges demand a break with conventional practice.[7] Much academic literature has emphasized the need to move beyond traditional, mostly technically and scientifically oriented, top-down approaches to deal effectively with environmental problems like climate change (Funtowicz and Ravetz 1991, 1993; Kloppenjan and Klijn 2004; Hage et al. 2005). Breaking with the rhetorical and institutional frames that constitute authority, organize relationships, and frame practitioners' competence is perhaps more challenging than these accounts acknowledge. It involves a reworking of the theories of action that represent the knowledge on which practitioners act, that are shaped by training, education, and the experience of working with similar problems, and that coordinate action (Schon 1992; Argyris and Schon 1996). A new problem like climate change and uncertainty is more likely, in this perspective, to be framed to fit with established patterns of practice than to disrupt them.

In this section we try to understand the interplay between the new challenges posed by climate change and this established system by looking at how a key feature –

[7]Doubt is perceived as the experiece of a problematic situation, triggered by a mismatch that is experienced as surprise, between the expected results of action and the results that are actually achieved in practice (Argyris and Schon 1996: 11).

uncertainty – is expressed in the stories of practitioners who are engaged in a large new water management project. The Delta Program IJsselmeer area (DPIJ) was set up to address issues of water safety, fresh water supply, ecology, and spatial planning affected by climate change.[8] We analyze the stories of 13 practitioners who play roles in this project from policy makers and (technical) experts to local stakeholders. All have been engaged in the DPIJ and confronted in one way or another the demands posed by climate change adaptation. We first review how practitioners engaged in the DPIJ perceive the demands of climate change adaptation and operate daily under this shadow of radical uncertainty. We then turn to look at how relationships between these professionals and local actors are understood and how conventional theories of action about how and why to engage local actors are challenged in this new context.

3.1 Capturing Certainty in Climate Models and Scenarios

We might expect the kind of deep uncertainty posed by climate change to have a dramatic and disruptive impact on local practice, opening doubt and confusion about what to do and why. The interview data do not support this proposition, however. We see a marginal impact. Practitioners do not respond to climate change and uncertainty as being disruptive of established ways of working. They manage the impacts as much as possible to maintain a workable environment that responds to demands and protects the conventional practice (Lividikou 2010).

The practitioners we interviewed frame climate change and uncertainty as a problem of incomplete, scientific information. Their accounts resemble the way uncertainty is described by the National Research Council (2009) for example. They seek to reduce this substantive uncertainty by generating new scientific information and developing more advanced forecasting models, as they remain confident in their practice. Thus climate change is perceived as a problem that can be solved by scientific means, if not now, later in the future then. Practitioners develop different coping strategies to deal with these conditions of uncertainty in the near future (Lividikou 2010). At the same time, they overlook the high levels of strategic and institutional uncertainty[9] that are present and need to be addressed to deal effectively with this "wicked" policy problem (Rittel and Webber 1973; Kloppenjan and Klijn 2004).

[8]The core task of the DPIJ program organization is to investigate the long-term development of the water level management in the IJsselmeer area, mostly related to issues of future fresh water supply and water safety in the context of climate change. The Delta Committee (2008) advised the Dutch government to raise the water level in the IJsselmeer Lake with 1.5 m. Such a decision will have major impacts for the local communities in that area and the natural environment. The high degree of uncertainty inherent to climate change, the multiple issues, and the multi-stakeholder character of this policy program form a challenge for the practitioners involved.

[9]Strategic uncertainty refers to the large varieties of strategic choices actors make with respect to complex, wicked problems. Institutional uncertainty is a result of the involvement of many different actors with different institutional backgrounds. These two forms of uncertainty form an intrinsic characteristic of complex policy problems (Kloppenjan and Klijn 2004: 6–7). Such problems also feature high knowledge uncertainty and high stakes (Funtowicz and Ravetz 1993).

The most important strategy practitioners use to cope with these high levels of uncertainty and unpredictability is to take climate scenarios and scientific forecasting models produced by others as a stable point of departure. Governmental institutions in the Netherlands rely on the four climate scenarios developed by the *Royal Netherlands Meteorological Institute* (KNMI) in 2006 (KNMI 2006). These scenarios are accepted by practitioners involved in water management as an authoritative description of climate change in the Netherlands. Carol, a policy practitioner working for the Ministry of V&W describes how she approaches these scenarios:

> In my opinion you have to approach the climate scenarios of the KNMI as a given. All four [climate scenarios] have the same likelihood to occur. Don't question [the scenarios] every time. Everyone knows they have an uncertainty margin, but no one knows what it should be otherwise. […] Work with them and don't say after that we don't know if it will occur and in what degree, so should we do it that way? I would like to approach it as a given, but be willing to actualize the scenarios every time [based on new information and research]. (Carol, Ministry V&W)

In Carol's view there is little to be gained from questioning the KNMI scenarios and so she takes them as a given in her work. In the absence of a better alternative, these scenarios are the best and most accepted way to guide action. The interviews with practitioners engaged in the DPIJ, as in the excerpt above, reveal a search for provisional stability in the face of uncertainty that will allow the practice to continue with only marginal adjustments. Practitioners accept the authority of the institution KNMI, and acknowledge uncertainty by working with the upper limits of its projections – the worst-case scenario–even though many perceive it as the most uncertain and even a controversial variant (Lividikou 2010). Kate describes the limits that oblige policy practitioners working at the *waterschap* to organize their work based on predictions of scientific models developed on a national level:

> We [as Waterschap] are not going to completely investigate these [climate] scenarios when we talk about that. But, we can point out [that] it will become drier in the summer and wetter in the winter and [the weather] will be more extreme. [And we ask ourselves] what influence does that have on the crops? What do you do then with the bulbs? (Kate, Waterschap)

Kate's comments illustrate how practitioners use these models, despite the underlying uncertainties, as a guideline that indicates changes that are likely, here in the seasonal variation in rainfall. This externalizes the uncertainty and allows them to ask how these changes might influence their field of practice and how they might adapt to these changes. Different interviews show how practitioners try to avoid the impression that there is a clear lack of knowledge or total ignorance with respect to the changing climate (Dessai and Van der Sluis 2007; National Research Council 2009), by focusing on the predictions that are relatively certain among the different climate models used to construct the KNMI (2006) scenarios. Practitioners do not perceive this incompleteness of information as a serious problem, but use these 'modeled facts' to maintain the stability of established technical approaches. This coping strategy is based, however, on a dilemma these practitioners experience as illustrated by Carol:

> If you take uncertainty as a point of departure [and we say] we know that with each other, but if we don't take measures now we will be too late, so this is what we will do. Then you keep making progress [in your work]. If you use uncertainty as an inhibitory factor then you won't get anywhere. (Carol, Ministry V&W)

Carol's comments show how practitioners' commitment to act is threatened by uncertainty. Deciding what to do is tightly bound with confidence about what will happen. It is better to accept the scenarios, despite their underlying uncertainties, and act, than become paralyzed by contemplating the uncertainty. Furthermore, practitioners try to short-circuit an infinite regress into discussions about the content and predictive power of climate scenarios, as these are likely to disrupt the commitment to act. This sense of urgency is rooted in the belief that it is not possible to postpone action until scientific uncertainties are resolved, but does not internalize the uncertainties into the conception of action itself (Dietz and Stern 1998; National Research Council 2009).

Ravetz, by contrast, argues that as we confront nature now, we find extreme uncertainties and unpredictabilities in our understanding of complex systems. These uncertainties are so extreme that they will not be resolved by mere growth in our databases or computing powers (1999: 650). Gunderson and Light argue that the belief that further modeling and monitoring will resolve uncertainties is a reason for failure (2006: 327). Practitioners' response to capture certainty in climate models, thus, is not expected to be helpful. As uncertainty is the only certainty scientists, experts, and practitioners have, seeking for a sense of temporary stability is an illusion, as reality might develop differently and unexpectedly.

3.2 Will Practitioners Be Able to Shift the Horizon?

Based on the forecasting models and climate scenarios discussed in the preceding section, practitioners and experts engaged in water management practices aim to develop highly technical and robust adaptation policies, for example strengthening the existing dikes (Lividikou 2010). Interviews with practitioners reveal an organizing commitment to *maakbaarheid*: a belief that desired physical and social changes can be realized by choosing the right governmental policies and engineering approaches (Petersen 2009). This commitment was revealed in comments like the following:

> The water world has always been very technically oriented, [characterized by] command and control and a belief in maakbaarheid. A lot has been constructed and we have had a lot of success with the Delta Works and it works as well. But, it requires a different way of thinking to really consider the uncertainties [of climate change] and to develop flexible measures. (Arthur, Waterdienst)

Arthur, who works for the Waterdienst (Rijkswaterstaat), shows how this belief in *maakbaarheid*, which is incorporated in the country's technical water management institutions, has become a theory of action that guides practitioners in their day-to-day work. His comments reveal how difficult it is to depart from the technical and scientific frame of the water management system and switch, for example, to more flexible strategies. As the next phrase shows, practitioners have the tendency to follow the same strategies or implement the same solutions just anticipating on a longer period of time:

> A dike is not designed on how the circumstances look right now, but has to be good for at least 50 years. It has to be sufficient over 50 years as well, when the climate scenarios become reality. But now we are going one step further [in our work]. We are not going to think 50 years ahead but 100 years […]. That is one extra step in the process of thinking about climate change. (Kate, Waterschap)

Kate makes clear how water defenses are built to withstand future developments, as they are not perceived as adaptable constructions, but seems to neglect that the character and magnitude of these developments may shift. Practitioners and engineers treat climate change as a matter of adjusting time frames to take a longer perspective, rather than adjusting their views of what it is possible to say about the longer term. Hans, a consultant at DHV, reflects on this tendency and suggests an alternative way of organizing adaptation policies:

> These [scientific] models too have uncertainties in them. It's just that people don't know that so well. It is actually wiser to think [if] we can develop [problem] solving strategies that are flexible [from a water technical perspective]. Rather than performing large dike improvements [all] at once, anticipating on a development of which we know it will take place, but don't know exactly how fast that will happen. That saves money, makes the impact on the environment smaller, and, thus, leads to lesser resistance. […] Rijkswaterstaat usually has the tendency to say: 'we want to design robust and plan 100 years in advance and [build] very strong dikes of which we know that they will not break'. (Hans, DHV)

Hans argues that the climate scenarios practitioners use have more uncertainties in them than people are usually aware of. Questioning these scenarios is difficult because of the way it disrupts the stability of the beliefs and relationships that constitute water management institutions (Schon 1973). Although flexible solutions may offer advantages, this is acknowledged to only a limited extent by governmental institutions. Technical knowledge developed within these institutions usually is rarely questioned as it is technical and complex, and because of the commitments that stand behind it.

Hans suggests a possible shift in the mode of learning that departs from the ambition to design robust water defenses to new goals and approaches rooted in flexibility. Adopting a new approach will require modifying organizational values and norms and a significant shift in the context of water management (Argyris and Schon 1996). Flexibility provides new resources to think about action in the context of climate change. Flexibility anticipates the need to adjust measures in the future and provides a framework to think about future generations and the welfare of new stakeholders, for example other species and the planetary environment as a whole (Laws 1999; Funtowicz and Ravetz 1993). Finally, flexibility can help shape a no-regret approach that is appealing given the uncertainties involved:

> I sometimes think [and ask myself] what do we regret now doing 20 or 30 years ago? Then you notice that we restrained the room for water. It is troublesome that we built the

> neighborhoods directly behind the dike; there we [are stuck] now. Deventer, Kampen, Nijmegen we all built them towards the river. […] Don't build in the same traditional way as we have done the last time. You must reserve [the land] to develop differently. Find a way to create more room, so that you can respond flexible to new developments. (Daniel, DPIJ)

Daniel, who works for the DPIJ program organization, describes the need to depart from the traditional way of doing practice that has often led to irreversible decisions and regrets. He points to the fact that past policies have created problems for planning and land use management, with enormous consequences for practitioners, for stakeholders, and for citizens who live there. He advises to reflect on traditional practices and to try to learn from past mistakes. He proposes introducing flexibility into practice and trying to invent new ways of planning and land use management that will meet stakeholders' demands and ambitions for development.

In practice, however, such transitions are difficult to realize within governmental institutions that have known long traditions of technically oriented practices. For practitioners it is difficult to operate within this complex institutional setting, which consists of various actors who have their own tasks, interests, and responsibilities and are characterized by their distinct organizational culture, values, and norms. The practitioners' stories support the fact that applied science is not sufficient to deal with a wicked problem like climate change, characterized by high levels of substantive, strategic, and institutional uncertainty and high decision stakes that reflect conflicting purposes among stakeholders (Kloppenjan and Klijn 2004; Funtowicz and Ravetz 1993: 750). The commitment to technically oriented ways of working is embedded institutionally however, and operates at a tacit level in the work of individual practitioners. The effort to minimize the need to adjust their practice is understandable. It underscores the significance of interaction with local actors and lay citizens who do not share in these commitments to the same degree and can provide a new perspective that can help experts and practitioners reflect on and reframe their theories of action (Funtowicz and Ravetz 1993, 1994; Laws 2010). We turn now to look at the relationships and patterns of interaction between professional actors and local stakeholders that are also guided by implicit theories of action and challenged by the demands of climate change adaptation.

3.3 NIMBY Perceptions Stand in the Way of Seeking a Model of Extended Peer Communities

Adapting effectively to climate change and responding to the demands posed by adaptation imply an ongoing need to make changes in plans and adjusting the institutions themselves, which is not really acknowledged by the practitioners involved (Funtowicz and Ravetz 1993). The theory of post-normal science highlights the significance of extended peer communities, consisting of scientists, practitioners, lay citizens, and local actors, in efforts to deal with the high levels of uncertainty that are present. Funtowicz and Ravetz emphasize the value of collaborative frameworks in which different stakeholder groups work together across institutional boundaries, policy domains, and organizational levels (Funtowicz and Ravetz 1991, 1993). In practice, however, the development of such collaborative frameworks is challenged in part because of the expectations and perceptions practitioners have towards local actors and citizens and the roles they adopt or are assigned to fulfill. The interviews with practitioners engaged in the DPIJ, who have confronted local controversies and conflicts in their practice, revealed an expectation that local citizens will engage in NIMBY behavior (Lividikou 2010). At one level NIMBY is absurd because climate change will unfold in everyone's backyard. At another, however, it is a powerful assumption that shapes practitioners' behavior and organizes the settings in which they encounter citizens and local actors, which is illustrated in the following stories.

The first example is provided by John, a policy practitioner working for a Dutch province, who argues how difficult it can be at times to engage local actors properly in the planning process:

> There is a certain larger interest than the individual interest of a small organization or citizen and that always causes tension. Because the citizen will say: 'why does my house have to be demolished, because you find it necessary to strengthen that dike?' And we say: 'yes, we strengthen that dike because all the people behind that dike need to be protected and your house needs to disappear for that'. That's basically what it comes down to. An individual citizen will always try to come up with alternatives or will oppose to that. As long as it's about abstract things like climate change, climate change adaptation, citizens think yes. [..] Until at some moment water storage comes in their area […], then suddenly it's ho ho, why here? [..] They go along until it comes into their backyard. (John, province)

John describes how he expects local citizens and residents to protest when policy decisions affect their backyards and sees as a part of his responsibility to ensure that those narrow views do not interfere with the efforts to address larger interests. In this story citizens are expected to fulfill a position of opposition and engage in NIMBY behavior. Carol, a policy practitioner working at the Ministry V&W, expressed a similar perspective in the project Groot Mijdrecht Noord and she describes how local residents became emotionally involved:

> A citizen […] thinks [and asks himself]: 'what are the consequences for me, for as long as I live?' But if you look at the province, the province stands for long-term decisions. And you cannot expect that a citizen will understand that all or will show understanding. […] You want to engage parties in everything, from policy till the farmer who lives in the polder. Involve them in everything and let them think along. But, that also requires that you [as a citizen] are willing to listen to other opinions and if you say at everything: 'no, that it's not true or we don't agree, and we have lived here for 100 years'. Yes, then it will become a very difficult discussion. (Carol, Ministry V&W)

Carol describes how challenging it is to engage local citizens and residents when they behave in a 'selfish' manner. Local conflicts and controversies develop because of the way citizens and stakeholders behave. In a context of climate change adaptation such situations will occur more often. The expectations these practitioners express will shape the way they engage citizens, the responses they get, and the kind of adaptation that develops in these relationships. They expect a narrow conception of interests that neglects long-term interests and lacks regard to others. They fail to grasp local actors' fears that legitimate interests will get lost in, or be overwhelmed, by the enormity of a broad, long-term future. John, for example, described the setting for adaptation in terms of a tension between individual interests, protecting one's house, and general interests of society, strengthening a dike. In his view, managing this tension means telling individuals that they have to make sacrifices for the common good. It neglects the idea that both interests are legitimate and good policy will work to find a way to reconcile them or face real costs in legitimacy and effectiveness. The stories of John and Carol refer to an implicit theory of action: citizens and local stakeholders will always oppose policy decisions that affect their backyard. Practitioners assume that all citizens and local stakeholders suffer from the NIMBY syndrome and only seek to maximize their own individual interest (Wolsink and Devilee 2009). This expectation/theory is partly derived from experiences. Based on this theory, they engage local actors as shortsighted and self-interested and frame local opposition they encounter as NIMBY behavior (Lividikou 2010). While they do that, they neglect the influence of their own underlying ideas on their perceptions and experiences (Wolsink and Devilee 2009). The following example from Margaux, a member of the citizen action group Angry Swans, addresses this issue:

> I have lived 25 years in this area. I started loving the area and started protecting it [..]. And not for myself, because they say it is Not In My Back-Yard, but that is not it at all. [..] I will be 62 in May. By the time it's built full we are 15 years ahead. […] I don't even have children. But I do it for the future generations and the people living in Amsterdam, because I think once you have built the area full you cannot reverse it. (Margaux, Angry Swans)

Margaux describes how the Angry Swans' actions and ambitions to protect the Markermeer Lake are often framed as NIMBY behavior, while in their own view they act from a feeling of commitment to future generations and a felt 'responsibility' to act against plans that threaten the area they love. In light of post-normal science, the Angry Swans would be described as active citizens, who care about their social, personal, and natural environment and could make valuable contributions to the planning process (Ravetz 1999: 652). Practitioners usually do not perceive their actions as commitments, however. They see citizens are engaged in NIMBY behavior, from which they cannot escape in their daily practice. These expectations and assumptions are based on past experiences and interactions with citizens and stakeholders that were not always pleasant. The conflicts in which they have been engaged have shaped their 'theories of action'. They seemed remarkably blind of the influence that their expectations and behavior could have on affected citizens.

The problematic relationships between professional actors and local stakeholders are challenged even more by the existence of long histories of suspicion and distrust towards governmental officials, which cannot simply be erased with good intentions (Forester 2006: 448) and often leading to local conflicts, as the next story describes. Kate describes how the *waterschap* she works for at some moment ended up in a conflict with local farmers. The *waterschap* needed to purchase land owned by local farmers in that area, but they were not amused or willing to sell their property:

> The way [to deal with such conflicts] is to find those elements that meet the interests of the users you want something from. But look, some people don't want that. And especially farmers [have to deal with] a lot of governmental interventions. And this is then a concrete mean with which they can be against [the government]. I can understand that. They said that

> themselves, this is a manner in which they can show resistance. And then it doesn't matter so much which government you are [...] I think that it then is your task, as a government, to enforce [your policy plan] because the public interest is greater than the individual interest. (Kate, waterschap)

Kate explains in this case how the *waterschap* made an effort and tried to find common ground and common interests, but, when this was not possible, the only alternative that was seen was for the *waterschap* to enforce its plans. Farmers also act on expectations shaped by a long history of distrust rooted in many governmental interventions. In Kate's eyes this becomes a habit of opposing every governmental policy decision, no matter how reasonable rather than a response to the unfair mode in which they perceive they are engaged by practitioners.

Such situations of local controversy can be expected to increase in the context of climate change adaptation. Thus, adaptation will, to a large degree be an effort to deal with local conflicts and its consequences. Forester addresses the need of understanding that citizens often do not just want to talk, but want to express deeply felt differences and defend a variety of interests (Forester 2006: 447). Especially when policy responses, as the ones suggested in the DPIJ, will influence local communities, will threaten the stability of regional identities, and disrupt people's belief in the constancy of some central aspects of their lives (Schon 1973: 9). This emphasized the significance of engaging local actors in a serious and constructive way in order to provide a basis for the development of extended peer communities. Practitioners have certain views and expectations with regard to local actors and how they are inclined to behave that prohibit them from engaging them in a new fashion. These expectations are based on prior experiences and interactions with local stakeholders, which have shaped the organizational and individual theories of action (Argyris and Schon 1996). Furthermore, the translation of these theories into working assumptions illustrate how NIMBY, as a theory of action, stands in the way of learning, reflection, and collaboration within extended peer communities (Lividikou 2010). However, despite these stories of opposition, conflict, and distrust, the practitioners engaged in the DPIJ have encountered unexpected behavior and surprising moments in their daily practice. These are moments that may disrupt their worldviews and expectations with regard to local stakeholders and citizens, prompt reflection and challenge their theories of action (Argyris and Schon 1996; Schon 1992). The following section describes some of these moments.

3.4 Citizens as Experts: A Myth Becoming Reality

At the same time that these dynamics that can be observed that shape perspectives on interaction with residents and citizens, the experience of practitioners working in water management includes moments of surprise that suggest new possibilities in these relationships.

> The nicest example is when we stood with our back to a nature area that was just realized with a natural channel. A large amount of water that was drained from the IJssel had to run

> through that channel. There was a new channel developed where also water had to run through, but it wasn't allowed to drain more water from the IJssel. So, nature organizations said: 'no, it must flow through the nature channel', thus, a problem. And a citizen, whose house was going to be moved, said: 'but why don't you let the water run through the new channel first and then through the natural channel?' That was actually a very good idea. [..] We had that idea examined and it seemed, from a river perspective, to work even better. Such an idea of a citizen was made part of the plan eventually and therefore the plan became more a unity. The quality of the plan was actually enhanced by the people who were initially against the project. You can't have it better than that. (Daniel, DPIJ)

The surprise Daniel describes can be explained in two ways. First, the practitioners who were engaged in Westerholte did not expect that a 'lay' citizen would come up with a way to improve the plan on technical grounds; surely if such a step were available the technical experts and practitioners would have come up with it themselves. The 'lay' citizen suddenly becomes more compatible with and interesting for those participating in the role of the expert. This shift is in line with the theory of post-normal science which suggests that: '*people not only care about their environment (social, natural, and personal environment) but also can become ingenious and creative in finding practical, partly technological, ways towards its improvement'* (Ravetz 1999: 652). Local people then can imagine solutions and reformulate problems in ways that accredited experts never could (Ravetz 1999: 652). This can be explained by the fact that these different participants do not share the same values, assumptions, and theories of action, and only within an interactive setting they can reflect on these implicit theories that guide their practices. Daniel was also surprised that a citizen, who would be forced to move, was willing and able to think along with the practitioners and help them enhance the quality of the plan. This moment of surprise prompted reflection and made him reconsider his approach to practice. His implicit theory of action, that citizens who are affected by governmental policy problems will do everything in their power to prevent the implementation of the plan, or at least will not actively contribute to the realization of the plan, was challenged.

Carol, a policy practitioner working at the Ministry of V&W, provided a different example of surprise. In Groot Mijdrecht Noord, a past project she had participated in, local residents had made a great effort to understand all the technical issues, which was quite unexpected for her:

> I know Groot Mijdrecht was very detailed. Very technical issues [were discussed]. Where the salt bells were and where the ground broke open. All the residents said: 'yes, that is clear'. They had all become experts, they knew almost everything. So it depends on the subject how, content wise, people are informed and amazing how much they sometimes know. (Carol, Ministry V&W)

In Groot Mijdrecht Noord local residents were very actively involved in the project that unfolded in the polder[10] in which they lived. This story describes the surprise Carol felt when she discovered that local citizens were engaged in a process of learning about their backyards. They became involved because they were worried about the effects the policy plans would have for their community and learned in a

[10] Polder refers to areas of land that are artificial.

context in an effort to protect their properties. Carol was surprised by the fact that these residents knew so much and had become experts themselves, even in such a technically complex arena. Both examples address situations in which local citizens and residents, whose lives and livelihoods depend on the solution of the problem, have some keen awareness and have made contributions as policy and practice unfolded in their backyards (Funtowicz and Ravetz 1991, 1994: 1885).

Frank, who works as advisor participation for Deltares, describes a final surprising moment. Some years ago he worked as an independent facilitator for the Newater project Kromme Rijn. During the participatory process he was surprised by a local farmer who was able to maintain a double vision that included both his individual stake and society's general interests:

> What I found funny was that a stock farmer said: 'yes, I find this a very good process and a very good plan, but I am still going to protest, because it goes past my [property]. I understand it's good for the general interest, but for my business [it's not]. I don't want to lose my land. I will object, and negotiate, and I want to be compensated. But I do that as an individual company. Beyond that I find it very good'. I found that funny that he [was able] to distinguish that like that. (Frank, Deltares)

The local farmer in this story says that the participatory process and the plan are good, but although he understands the significance of this plan for the greater good, he has to defend his own financial interest. The story of the Kromme Rijn proves that it is possible for citizens to acknowledge and consider other interests than their own and such stories challenge the theories that guide practitioners' actions. Their expectations that local citizens are only capable of engaging in selfish NIMBY behavior turned out to be false. These moments suggest that local stakeholders and citizens are not only able and willing to consider society's long term interests, but are also capable of engaging in processes of learning and can become experts themselves, which is perceived as crucial in a context of climate change adaptation. Such moments have implications for the way roles and positions are fulfilled and for the patterns of interaction that develop with and among stakeholders groups.

In order to acknowledge the transformation of the existing roles and positions and act upon it, practitioners have to depart from the hard-core scientific and technical frame, in which only scientists and engineers have something valuable to contribute and are capable of reasoning appropriately. This is valuable since local stakeholders and lay citizens' perspective can help enhance the quality of the 'scientific' dialogue with their local knowledge. They can provide a new, 'lay' perspective, precisely because they do not share assumptions with experts and policy practitioners (Ravetz 1999; Wynne 1996; Jasanoff 2003). Engaging local stakeholders and citizens then, is a condition that needs to be met for successful adaptation, in the present and the future.

4 Conclusions

In the preceding sections we have tried to develop a snapshot of water management in the Netherlands as the shadow of uncertainty thrown by climate change begins to fall upon it. This image is built up from the comments and reflections of the professionals who are responsible for and involved in managing security around water. Their stories reflect the image of a set of practices linked by procedures, conventions, and institutional and professional relationships. Uncertainty is managed with respect to the day-to-day demands of decision-making. Plans have to be finalized, judgments have to be made, and decisions have to be taken to keep the system of water management working. These moments of choice involve commitments that require a foundation in belief and certainty, however provisional the base on which this is built. Building a foundation on sand is better than having no foundation at all.[11] The system of relationships and processes is directed at producing the certainty needed to act. A side effect of this is that the very uncertainty that concerns us here is black-boxed in this system of production and its significance for downstream choices is muted or lost altogether.

The actors who inhabit this system work in a similar manner. They face day-to-day demands and must manage the implications of uncertainty in order to be able to act. They use a variety of strategies to keep uncertainty at arms length and control its impact. To let doubt bloom so close to the core of their practice would be debilitating in a system that depends on them to provide the forecasts, plans, and judgments that facilitate action on a daily basis. Relationships contribute to the stability needed to make the system work and rethinking relationships in the context of action can be difficult, even when the practice itself provides experiences that suggest such rethinking is needed and that highlight the new opportunities that a rethinking might offer.

The image we have constructed does not suggest a system that is rudderless or in disrepair. Safety is at historically high levels and the system continues to function smoothly. It is entirely possible that it could continue to function adequately as the shadow of uncertainty deepens. Its core commitments are likely to become more and more at odds with experience, however, raising the possibility of "normal accidents" that reveal the mismatch between commitments and experience (Perrow 1999). Postponing the development of internal practices that could recognize and engage such moments of surprise will limit the ability of the professionals to make sense of their experience, adapt their practice, and, in the process, invent what it means to practice "beyond the stable state" (Schon 1973).

If such invention, or better reinvention, is to start and develop it will have to do so from within the practices that make up the competence needed to manage water and address the risks of climate change. Moreover, it will need to be done while still addressing the ongoing needs for management. We will need, in Neurath's (1932/33) phrase, to rebuild the ship as we sail it. In a system with as highly developed a structure and level of competence as water management in the Netherlands, this rebuilding will have to proceed one plank at a time and as opportunity presents itself. It is not clear where such opportunities will come from and when they will arise. It is unlikely that all parts of the system will need to be rebuilt. Some are bound to continue to function well, even if in unexpected ways.

As a starting point for thinking about this rebuilding we suggest the following as a hypothesis about some features of a practice that might be up to the task.

[11] Howard Raiffa.

Cultivate the capacity for surprise and doubt: One of the biggest challenges will be to cultivate the capacity to engage doubt in a system that persistently demands certainty (even if certainty about uncertainty) and in which the mark of professionalism is to provide such certainty to groups that are unsure about what kinds of plans and actions make sense. In such circumstances, doubt is not valued, and to see it as an experience that can provide insights into the way tacit commitments are shaping perceptions and actions will itself require learning. Such moments of surprise – in which there is a mismatch between expectations and experience – can be valued for the way they signal the need to reexamine the assumptions and commitments that are shaping action. Professionals working in these arenas must learn to recognize and disrupt the natural and understandable reflex to marginalize doubt and limit the impact of surprise in order to preserve their working sense of competence. When these reflexes are interrupted and the events that trigger doubt can be examined, they will often provide insights into why the system of actors and ideas is challenged by the problems that are on the table at a given moment in time. Petersen et al. (2011) have shown how guidance materials derived from the theory of post-normal science can assist expert practitioners in dealing with uncertainty and stakeholder perspectives.

Treat goals, plans, and standards as hypotheses. Under the shadow of radical uncertainty, goals, plans, and standards, become less an expression of commitment and more a guess about future circumstances, options, and preferences. The idea of commitment must be reworked to fit with this new understanding of the context of action. Regulatory arrangements like "rolling rule regimes" suggest the direction in which such development might occur. Rather than treat regulatory standards as fixed commitments, rolling rule regimes emphasize the need to reconcile the demands for learning and accountability in systems of regulation. They hypothesize a relationship between process norms that define how a problem should be handled and performance norms that define acceptable outcomes. (Simon 2004:34) They monitor implementation to inform deliberation on this relationship and allow for revision of both in light of experience (cf. McCray et al. 2010). While not an answer per se, the move from fixed standards to rolling rules suggests the direction that such developments might take.

Treat action as a site at which knowledge and legitimacy can be negotiated. Action is likely to bring new actors into play and with them diverse background experiences, interests, and aspirations. Different views about what kind of knowledge is needed and relevant for action are likely to be as divisive as questions about interests and priorities under these circumstances. The most likely way to be persuasive and develop a shared commitment to action is to be open to the reason and priorities of others. Negotiation becomes a practical strategy for handling difference and the potential for escalation it raises. It also provides a way to think about how to manage diverse sources of insight and make commitments that reflect the dynamics of issues and settings and the need for revision (and renegotiation) that they create. Legitimacy in such settings is likely to be derived from the way stakeholders experience the planning and implementation process. By keeping the system open to their diverse experiences and priorities and, at the same time, emphasizing the need for commitment, policy practitioners can contribute directly to the legitimacy of planning and action programs.

Rely more on leadership and less on authority: Professionals who have responsibility for developing and implementing plans have historically drawn on the authority provided by their positions and expertise to provide a basis for their leadership around controversial questions of public management. As expertise is viewed more critically and the active participation – or at least assent – of diverse stakeholders is needed to commit to action and to revise plans in light of experience, there is a need to separate leadership from these compromised sources of authority. Leadership can be understood in such settings as the ability to help people face the need to work on collective problems that have multiple stakeholders who don't necessarily agree on the problem at hand or on how to address it. Leadership in such circumstances consists in the activity of mobilizing others on behalf of the shared or overlapping purposes that bring them together. It involves creating a sustained capacity for reflection on the commitments that shape action and the way these may be stood on their head by changing circumstances. Such reflection is essential for helping the individuals and groups involved rethink these commitments, reach agreement on practical options for action, and handle the demands that such changes place on them.

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Chapter 15
Adapting to Changing Climate: Exploring the Role of the Neighborhood

Herman A. Karl, Lynn Scarlett, Paul Kirshen, Rebecca Dell, Hauwa Ibrahim, Laura Kuhl, Trannon Mosher, Bridget Navarro, Megan Rising, and Nathan Towery

Abstract Climate change adaptation is local and place-based. Local places are often heterogeneous with respect to a number of elements that include geography, infrastructure, culture, economics, politics, and ethnicity. Neighborhoods in large cities and metropolitan complexes reflect this diversity. Thus, it seems to us that climate change adaptation planning should take into account the peculiarities, vulnerabilities, and assets for building resilience of each neighborhood. We suggest that neighborhood climate change adaptation plans should be developed through a consensus seeking, participatory process in collaboration with and guided by a comprehensive city-wide planning process. We examine the city of Boston, Massachusetts in this light.

Keywords Climate change adaptation • Place-based • Neighborhood • Community development • Urban planning • Climate change mitigation • Resilience • Vulnerability • Adaptive management • Land use • Environmental justice • Boston • MA

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1 Introduction

Science, politics, and action – both public and private – converge in efforts to sustain and restore the health of lands. Climate change increases the urgency to find ways to manage lands and natural resources more effectively because it magnifies and accelerates landscape changes. Yet action requires agreement about the nature of anticipated problems and motivation to address those problems. Achieving that agreement and motivation lies at the intersection of science and politics, which is, in turn, shaped by social and economic dynamics.

Though climate change dynamics are global in scale, the effects of a changing climate play out in different ways regionally and locally. Thus, much productive action will be at the local level by grass roots initiatives. Climate change will result in some human migrations, particularly in low-lying coastal regions. These migrations may exacerbate stresses on natural systems. We explore the role of urban neighborhoods in adapting to the effects of changing climate to learn what strategies could be effective in preserving lands, natural resources, and infrastructure in the face of ecosystem effects that result from climate change coupled with continued changes in human settlement patterns. Starting with a theoretical framework of the incentives for neighborhood based adaptation, we finish with its potential application in Boston, Massachusetts, which is already considering decentralized and neighborhood adaptation planning.

For the last two decades, society and governments at all levels have focused their attention on climate change mitigation – the reduction of green house gases (GHG). However, even if we were to reduce all GHG emissions to zero tomorrow, the latent effects of these gases would continue to drive climate change for centuries (e.g., global sea level will continue to rise, global temperatures will continue to warm, and storm and precipitation patterns will continue to change). Though reducing GHG emissions remains an important focus, current and projected climate change impacts already set in motion suggest the importance of lessening the impacts of climate change. Communities and resource managers must adjust or adapt to changing climate conditions as well as continue mitigation efforts. Many communities, cities, and other governments are developing climate change adaptation plans; mitigation must be integrated with adaptation.

The risks associated with climate change, especially at local and regional (as opposed to national and international) scales remain uncertain; hence, we must develop flexible and adaptive strategies to mitigate and manage their impacts. Considerations of scale are important. Will existing institutional arrangements and governance give us the information and coordination that we need to respond in a timely and effective manner to the risks associated with climate change? Will those institutions support successful application of the principles of adaptive management and ecosystem-based management, or do they require modifications (and if so, how)? Can the principles and techniques of collaborative adaptive management, adaptive co-management, and networked or collaborative governance help us adapt to the impacts of climate change? An essential part of any adaptation plan is ongoing monitoring – is the plan achieving its goals? As new information emerges, it may be necessary to make changes (that is to adapt) to achieve the goals of climate adaptation plans.

But what does adaptation mean? We refer to adaptation as strategies that enable communities and societies to become more resilient in the face of change, and, thus, more sustainable. We define community sustainability in terms of functionality of infrastructure and the built environment, the protection of ecosystems and their services, risk-reduction, community acceptance, health and well being, and governance capacity. Climate change impacts the physical elements of built and natural environments and affects socio-economic processes. Cities, for example, are dynamic, open, and interconnected systems. The social, ecological, and economic elements of cities are interrelated and influenced by internal demographics, geography, and cultures, along with external factors. Resilient community development requires that cities and other communities are capable of dealing with stressors and changing conditions while maintaining their essential social, economic, and ecological functions. Adaptation to climate change needs to be incorporated into planning to achieve resilient community development. Therefore, both internal social, economic, and political dynamics and external influences related to climate issues need to be considered.

Our approach recognizes that different community settings and circumstances may require different technical and institutional approaches to climate adaptation, risk reduction, and mitigation. A "one-size-fits-all" technical and institutional approach is unlikely to meet the varying needs of different communities. Nonetheless, certain decision-making features and characteristics may enhance the effectiveness of climate change action plans, in terms of technical robustness, economic feasibility, and community acceptance.

Climate change adaptation is an ideal issue to address at the neighborhood level. One of the key challenges of climate change is that it is a global issue, requiring coordinated action globally to mitigate GHG emissions. Adaptation, however, has very different qualities, and is, at its heart, a very local matter. Climate impacts, while generated globally, will be felt locally, thus making the local level most appropriate for formulating responses. Continued international, national and regional frameworks to address GHG emissions and build strategies to adapt to climate change effects are necessary. However, these efforts must be accompanied by local action to address the manifestations of climate change that affect communities.

International and national organizations are developing protocols that urge adaptation. Yet these protocols are insufficient. Because climate effects are location-specific and variable across regions, adaptation requires community planning and grass roots initiatives. Such efforts will affect local citizens in different ways, amplifying the importance of collaborative engagement and participation of stakeholders, scientists, and policy makers in adaptation decisions.

The underlying premise of this essay is that collective action, at all scales and levels of governance and society, is needed to address the impacts of climate change to achieve sustainable societies and ecosystems. An essential and critical part of this premise is the imperative of representing the wide range of interests, insights, knowledge, and experience that resides in a highly diverse society. Diversity can often result in conflict. Conflict is sometimes viewed as destructive. Yet, when managed well, it can result in creative solutions to societal problems. Thus, it is important to bring together the diverse interests in a well-designed collaborative process that builds consensus.

Cities and surrounding regions are not homogeneous. They are an aggregation of neighborhoods and communities, each of which is distinguished by physical, economic, social, and cultural characteristics with individuals that hold different sets of values and worldviews. Climate change adaptation planning, with few exceptions, has emphasized international, national, regional, and citywide scales. We examine the neighborhood scale and propose a way to integrate it with higher levels of adaptation planning.

2 Theoretical Frameworks

"Management power and responsibility should be shared cross-scale, among a hierarchy of management institutions, to match the cross-scale nature of management issues" (Folke et al. 2005). Sharing implies coordination and collaboration, which require melding of diverse interests, worldviews, and values. In this section, we explore the theoretical underpinnings of collaboration, adaptive management, and the role of values and community. We emphasize the importance of collaboration in multiple forms. With regard to the institutional forces and governance structures that shape and condition all efforts to manage responses to threats such as climate change, we highlight the challenges of assembling a navigable path. Additionally, we discuss the implementation of adaptive management strategies for other efforts to plan for climate change adaptation. Finally, we discuss the role of values and seek to refine the definition and importance of communities as we set forth the perspective that climate change adaptation at the community or even neighborhood level has distinct advantages over other levels of planning and implementation.

Collaboration is key to any adaptation effort that, like climate change adaptation, reaches across multiple constituencies and levels of governance. City-level planning is necessary to ensure that vulnerable neighborhoods are not disadvantaged in the planning process because they have fewer resources available to advocate for themselves in the planning process. Additionally, a holistic approach is needed to ensure that key priorities are not overlooked and efforts are coordinated. However, particularly at the implementation stages, neighborhood level efforts may be more appropriate. Different neighborhoods will have specific needs and will be able to draw on their own unique strengths in the adaptation process. Implementing adaptation measures will require action on the part of individuals and can't be implemented in a top-down fashion (Wisdell 2003; Reid et al. 2009; Scholten 2009). Neighborhood level organizations are best positioned to mobilize individual households to partake in the adaptation process (for example, in areas of chronic drought, on-site rainwater capture may occur at the household level). At the same time, we cannot lose sight of the regional nature of climate impacts. Adaptation plans need to incorporate these regional considerations, and local efforts will need to be coordinated with both State and Federal plans and surrounding municipalities.

Collaboration is a decision-making process through which to incorporate the viewpoints and knowledge of multiple stakeholders, and to engage those stakeholders in the implementation process. In *Making Collaboration Work*, Wondolleck and Yaffee (2000) note that resource management actions – like climate change adaptation – must "operate on different geographic and temporal scales; deal with complexity, uncertainty, and change; acknowledge and make sense of the community of interests; decentralize decision-making; and provide images of success" (14). They see four applications for collaboration in environmental management, which we see as especially relevant for climate change adaptation. These include:

- Building understanding by fostering exchange of information and ideas among agencies, organizations, and the public and providing a mechanism for resolving uncertainty;
- Providing a mechanism for effective decision making through processes that focus on common problems and build support for decisions;
- Generating a means of getting necessary work done by coordinating cross-boundary activities, fostering joint management activities, and mobilizing an expanded set of resources; and
- Developing the capacity of agencies, organizations, and communities to deal with the challenges of the future (18–19).

Each of these four elements is challenging to implement, and cities should think carefully about each component when devising climate adaptation plans to ensure that they adequately prepare for each component. Particularly for complex problems such as climate change, where the risks are uncertain and the solutions are not clear, adaptive management and collaborative approaches are essential to maintaining both the socio-political and ecological health of a changing system.

Risks associated with climate change present significant uncertainties, especially at local and regional scales. As such, in addition to collaboration, we must develop flexible and adaptive strategies to mitigate and manage their impacts and that can be applied across multiple jurisdictions. **Adaptive management** is one such strategy. We use the definition given by Armitage et al. (2007):"co-management … is adaptive where ecological knowledge and institutional arrangements are tested and revised in a dynamic, ongoing, self organized process of learning-by-doing." In the domain of managing natural resources, adaptive management is the result of moving away from management by "top-down control, production, and measurement of objectives by narrow criteria" (Wondolleck and Yaffee 11) and towards a management approach that recognizes the changing nature of our goals and our understanding of socio-ecological systems. Climate adaptation and adaptive management are distinct concepts. The former refers to any strategy used by resource managers and communities to address the effects of climate change, such as strategies that protect coasts from high-intensity storms or conserve water in increasingly drought-prone areas. Adaptive management refers to a dynamic management process, whether in the context of climate change or other circumstances, in which goals are set, actions are taken to achieve those goals, results are monitored, and actions are adjusted based on new information.

Adaptive management theory incorporates notions of resilience and robust problem resolution In "Surprises and Sustainability," Gunderson, Holling, and Peterson discuss the notion of resilience, noting that resilience is not just a feature of physical systems but also found in social and combined social-physical systems (2002, 323). Walker and Salt argue that resilience is "about understanding and engaging with a changing world. By understanding how and why the system as a whole is changing, we are better placed to build a capacity to work with change, as opposed to being a victim of it" (2006, 14). A focus on resilience through collaborative adaptive management of complex problems like climate change adaptation is important, given uncertainties and differential environmental, societal, and economic effects. Capacity for resilience is mediated somewhat by governance structures and the institutional forces in which adaptation planning takes place.

During the 35 years since adaptive management was pioneered and has evolved (Holling and Chambers 1973; Walters 1986), only a handful of adaptive management experiments have been successful worldwide. A principal reason for this is that governing institutions applying adaptive management are seldom adaptive and flexible. They are hierarchal and prescriptive. Thus, they are at odds with the underlying premise of adaptive management.

As the environmental management literature describes, proactive institutions can successfully embrace adaptive management strategies for addressing complex problems analogous to climate change adaptation (see, e.g., Folke et al. 2005; Layzer 2008). However, Gunderson, Holling, and Peterson note that institutions often struggle to implement or embrace resilience planning (related to adaptive management strategies), writing: "there are many situations where the institutions constantly struggle with resolving those uncertainties; and those with high… institutional inertia can be described as unable to reinvent themselves and adapt to changing conditions. Many agencies appear incapable of generating either novel solutions or policies to solve chronic resource problems" (2002, 325). We believe that a major challenge will be to form those institutions that can embrace change and respond to emergent properties that manifest complex, coupled natural and human systems. Institutions at the most local level may be most amenable to experimenting with change, both because of their smaller scale and because of their direct proximity to constituents.

One of the challenges for collaborative processes and using such an approach for planning purposes is the need for **shared values,** though shared values need not correspond to shared worldviews or political and economic philosophies. Without both a shared vision and clearly defined goals, the collaborative process can easily be reduced to "lowest common denominator" decisions. Before suggesting a collaborative approach to climate change adaptation, it is essential to both consider the role of values in decision-making, and the potential limitations that divergent values may place on collaborative processes. Mattson, Karl, and Clark (Chap. 12) define values as “somatic and psychological indulgences desired or otherwise sought by people,” and suggest that values can be best understood at three levels: “(1) specific to singular things or experiences, such as a wilderness outing at a particular time and place; (2) specific to cultures, societies, or technologies, such as “wilderness” or off-road vehicular recreation; and (3) broadly applicable to the human condition, regardless of time, place, or culture, which is the conception we offer here” (2). Building on Maslow’s hierarchy of needs (1943), Mattson, Karl, and Clark (Chap. 12) suggest that values are different than preferences, attitudes, worldviews, and behaviors, and describe them as functional and fluid.

We suggest that members of any society can maintain different functional values related to different scales, institutions, and organizations within their societal membership. For example, ranchers, anglers, and the conservation community all may share the goal of reducing erosion to achieve the value of cleaner water in a local stream but may diverge in how much priority they place in water quality in relationship to other values such as education, health care, or economic opportunity in a context of national decisions on budget allocation or regulatory regimes. All stakeholders in a process may not share certain values, and, if the values of some critical players are not amenable to collaborative processes, other tools, including regulation, may be necessary.

While addressing values explicitly can help garner consensus, adaptation will require a broad toolbox of policy options. Some tools are more appropriate at different scales of action. Consensus-driven collaborative processes will be particularly useful for neighborhood-level adaptation options. We suggest that community-scale values in which stakeholders face similar climate change effects are inherently more amenable to the successful development and (more importantly) implementation of climate adaptation plans.

Community can be defined in many different ways – formal, geographic, ethnic, and cultural (see, for example, Chap. 19). The wide variety of potential conceptions of community makes the term challenging to use in discussion and equally challenging to use when implementing policies. Mead (1934) defines community in terms of the social processes that individuals engage in that allow them to form bonds. Mead argues that people form community acting “purposefully in response to their conceptions of connections among themselves” (Wilkinson 1991: 15). Such a socially oriented conception of community will clearly not align perfectly with more formal definitions of neighborhoods or other geographic boundaries, although there may be significant overlap. This reality makes implementation of community-based planning approaches difficult, especially when politically constructed communities are not coincident with more organic, social communities of shared values. While recognizing the inherent challenges of identifying boundaries that reflect communities with shared values, we argue that such an approach will lead to greater coherence in the process implementation success (see Chap. 19, for one approach to mapping communities).

3 Challenges of Translating Theory into Practice; Boston – A City of Neighborhoods

While many cities throughout the United States have began to develop climate action plans, it is worthwhile to examine the potential for neighborhood-based adaptation planning in Boston, MA. Boston proudly proclaims itself as a "City of Neighborhoods" with its 23 distinct areas.

3.1 Governance Structure

As Mayor Menino has proudly proclaimed, Boston is a "City of Neighborhoods" [Menino, April 13, 2006 press release, available at http://www.cityofboston.gov/news/Default.aspx?id=3141]. One important aspect of Menino's legacy as Mayor has been to recognize the strength of Boston's neighborhoods and capitalize on this strength through the integration of neighborhood community development into City structures. Although a city of neighborhoods, the city has a strong mayoral-form of government. Because of this, and Mayor Menino's message to City Hall and residents that climate change is of major concern, the mayor's office can play an important leadership role in helping to coordinate among City Hall and the neighborhoods. Two such examples are the Boston Redevelopment Authority (BRA), which leads Boston's efforts in planning, economic development and workplace development, and the Office of Neighborhood Services (ONS), which seeks to foster citizen input and participation in government decision-making and plays a role in coordinating emergency response. The BRA organizes its planning and economic development activities along neighborhood lines, and the ONS and its community liaisons directly connect the Mayor's office to local constituents. With such structures already in place, Boston is well positioned to implement a neighborhood-scale approach to climate change adaptation.

Boston's current governance structure for creating and implementing climate change policies is decentralized by agency. While James Hunt,[1] a member of Mayor's cabinet with significant operational authority, coordinates the City's climate mitigation and adaptation plans, the responsibilities for developing and implementing individual aspects of the policies are carried out by key players within different agencies. This decentralized structure capitalizes on the particular expertise of each agency, commission and department to assess how climate change might impact its unit's functioning and to plan accordingly. For example, the BRA has developed new mechanisms for assessing how well plans for a proposed new building incorporate sea level rise or other potential climate impacts (Meeting with John Dalzell,

[1] He is head of the Environment Department and oversees Parks and Recreation, Inspectional Services, and Energy Policy.

Senior Architect BRA, April 26, 2010), and the Office of Emergency Preparedness monitors climate science to inform disaster management risk assessments and plans (Interview with Don McGough, Director Office of Emergency Preparedness, February 4, 2010). The Boston Water and Sewer Commission collects rainfall data from points around the city to inform their planning and is incorporating sea level rise and changed storm-frequency projections into their 2010 master sewer plan (Interview with John Sullivan, Chief Engineer Boston Water and Sewer Commission, March 2, 2010). The coordinator's role is to share relevant scientific information, ensure coordination between the agencies, mobilize agencies to take relevant actions, and liaise among the various constituencies. The coordinator also helps to implement the public involvement component of the process and acted as the City's point person for the Spring 2010 series of citywide climate change workshops.

While this governance structure optimizes expertise, facilitates ownership and encourages the implementation of concrete solutions to the challenges of adaptation, it also faces inherent challenges. The success of a climate governance framework hinges on effective leadership, and, in the case of Boston, much rests on the shoulders of one coordinator (Holling and Chambers 1973; National Research Council 2009, 64). Effective leaders can help to overcome institutional barriers, facilitate communication, maintain momentum, ensure science-based policies and ensure policy coordination; they are a critical component of an effective governance structure for responding to climate change impacts (National Research Council 2009, 64). Ensuring effective leadership for this process is a significant challenge.

A second challenge for Boston is that the agencies that play a role in climate adaptation have different accountability structures and relationships to the Office of the Mayor and, therefore, the coordinator. For example, the BRA, Boston Water and Sewer Commission, Boston Housing Authority and the Boston Public Health Commission are all legally independent from the City of Boston. While the Mayor appoints the head of each agency, each reports to its respective Board of Directors and does not fall under the Mayor's authority. Other agencies such as the Department of Transportation, the Environment Department and the Office of Emergency Preparedness do fall directly under the Mayor's authority. This multitude of accountability structures makes policy coordination challenging and requires that each agency is convinced of the need to take action to adapt to climate related impacts.

Another challenge is that at times taking action across sectors is necessary because many of the functions of sectors interact with each other (Kirshen et al. 2008) For example, drainage problems impact water quality as well as transportation and public health. Given Boston's decentralized approach placed in the different agencies, this may be difficult to accomplish in Boston. A related challenge is that regional plans have the advantage of allowing planners to consider the diverse needs of a region, consider overlapping needs, and prioritize goals. Regional approaches also allow for wider expertise and resources to be utilized in the planning process. These are challenges for distributed adaptation planning that must be overcome but we contend it is valuable to manage these challenges in order to capture the deep advantages of a decentralized based approach, particularly if based in neighborhoods.

3.2 Progress on Adaptation

The City of Boston is a leader in mitigation and adaptation, and its plans have been innovative in several respects. The City's involvement on climate issues dates back to 2000, but the most significant action came in 2007 with the Mayor's Executive Order, which set clear greenhouse gas (GHG) emissions reductions goals and called for a review of its Climate Action Plan every 3 years. Under the Mayor's leadership, the process for updating the Climate Action Plan in 2010 involves the input of a wide range of community members and incorporates an in-depth analysis of the economic impacts of each mitigation policy proposal.

The Mayor has created two citizen committees that help to facilitate broader participation in climate change decision-making and who are charged with providing recommendations to the Mayor regarding the 2010 updates to the Climate Action Plan. The Climate Action Leadership Committee consists of 22 members, including elected officials, city officials, and youth, non-profit and corporate leaders. The Community Advisory Committee on Climate Change comprises community, business and institutional leaders with representation from each neighborhood of the city. The Advisory Committee organized five community workshops in early 2010 that were intended to update and solicit input from residents on how climate change is impacting the city and inform them of strategies to save energy and reduce their GHG impact, as well as to solicit input for the City's updated Climate Action Plan. Also playing a behind-the-scenes role in the process of updating the Climate Action Plan are Raab Associates, who was hired to facilitate the process, and the Barr and Boston Foundations, who provided the necessary funding. These Committees developed a series of recommendations, released by the Mayor on Earth Day 2010, which will inform the City's updated Climate Action Plan.

Although many of the Leadership and Advisory Committees' recommendations to the Climate Action Plan relate to mitigation efforts, the recommendations indicate that the City should "give adaptation the same priority as mitigation" (Boston Climate Action Leadership Committee and Community Advisory Committee 2010, 9). The level of specificity and detail in the mitigation section is significantly greater than in the adaptation section and more mitigation recommendations are given. The five recommendations[2] for adaptation, however, are quite broad and all encompassing and probably reflect the general lack of knowledge of adaptation planning rather than disinterest in it. Community engagement for both mitigation and adaptation planning is seen as important, in fact, the third longest of the five chapter report is on this topic. The engagement strategy consists of:

1. "Partner with and share responsibility for Boston's climate goals with community organizations to promote climate action at the neighborhood level.

[2] These five recommendations are from the summary chart of the full Climate Change Action Plan report. There are ten major and many minor recommendations.

2. Encourage community involvement in policy development, program planning, and assessment.
3. Support a long-term, ongoing, city-wide awareness campaign that frames climate action in the context of broad community concerns, informs people about climate action, and motivates them to act.
4. Equip individuals to take action and influence their peers.
5. Continue to lead by example" (page 46).

How could the City develop a neighborhood-based approach to vulnerability assessment and designing and implementing an adaptation plan that contains the previously described elements of collaboration, adaptive management, and shared values ? Here we present several outlines of such a strategy.

3.3 Neighborhoods

As described above, Boston will continue to engage its diverse communities in its climate change planning efforts. Expanding this approach is particularly important for effective climate change adaptation, as the vulnerabilities, strengths, and appropriate responses to the climate change risks identified by the Climate Change Adaptation Working Group vary significantly from one neighborhood to another. To demonstrate this community-scale diversity, in this section we describe several different neighborhoods in Boston, and highlight some of the characteristic features of each that would be best served by a neighborhood-based approach to climate change adaptation.

3.3.1 East Boston

East Boston is one of the most vulnerable communities in Boston and will require greater care in both physical and social adaptation to climate change. It is both low-lying – and, thus, vulnerable to coastal flooding – and has been designated as an environmental justice community by the Massachusetts Office of Environmental Affairs because it contains a segment of the population most at risk of being unaware of, or unable to participate in, environmental decision-making or to gain access to state environmental resources (Massachusetts Executive Office of Energy and Environmental Affairs 2007). It is surrounded by water on three sides and is, therefore, geographically isolated from the rest of the city. In addition, because of the presence of Logan Airport, much of the coastline is zoned as "Designated Port Area", which may interfere with non-infrastructural efforts to mitigate the threat of sea level rise or flooding. For example, wetlands restoration efforts that may be in the best interests of the East Boston residents are not necessarily good for the Port of Boston. Zoning and regulatory designations such as this may have unintended consequences for climate change adaptation.

In addition to these physical and regulatory vulnerabilities, East Boston is less able than many areas to guide its own adaptation to climate change. It has a large minority population, and 55% of residents speak a language other than English at home. The income level in East Boston is well below the median for the state, and over 20% of households live below the poverty level (Boston Redevelopment Authority 2003a). Furthermore, vehicle ownership is well below the regional average and long travel times by public transportation to destinations within the Boston-metro area contribute to a sense of isolation, as well as presenting barriers to accessing some services, jobs and opportunities, or to evacuating in the case of an emergency (Douglas et al. 2008). At the same time, East Boston has many strengths to build upon, especially numerous neighborhood-based organizations that have ties to and trust within the community and are interested in working on climate change adaptation. Two prominent groups are the Neighborhood of Affordable Housing (NOAH) and the Chelsea Creek Action Group. These organizations are already involved in the kind of work required for climate change adaptation, like improvements to housing and water-hazard reduction. They are already aware of the need for climate change adaptation and could contribute greatly to citywide climate change adaptation efforts through their local knowledge and connections. More details on climate change adaptation planning in East Boston are given in Chap. 5 of this book by Paul Kirshen, Ellen Douglas, Michael Paolisso and Ashley Enrici.

3.3.2 Back Bay

Back Bay shares with East Boston some sources of physical vulnerability to climate change, but its socioeconomic status suggests that it may not require the same level of assistance from the city. Like East Boston, it is built on landfill and is only a few feet above sea level. However, it is predominantly (85%) Caucasian and has a median household income 1.7 times greater than the Boston average (City of Boston Department of Neighborhood Development 2006). Its Neighborhood Association is already well aware of potential problems from climate change; for example, possible degradation of the wood pilings that compose the foundation for 95% of Back Bay's buildings, if ground water levels drop (Neighborhood Association of the Back Bay 2010). Extensive efforts are underway to monitor ground water levels around Boston and educate the residents of Back Bay about what precautions they can take to prevent piling damage (Boston Ground Water Trust 2010). To this end, the Boston Ground Water Trust has invested in drilling wells for water level monitoring. Like community groups in East Boston, these local organizations in the Back Bay can build upon existing work to provide climate adaptation support and planning. Coordination with such groups is vital for a comprehensive citywide adaptation strategy.

3.3.3 Chinatown and Roxbury

Other Boston neighborhoods also have distinctive attributes that necessitate attention to small spatial scales when planning for climate change adaptation. Like East

Boston and Back Bay, Chinatown was constructed on landfill in the 1800s (Boston Redevelopment Authority 2010), and, therefore, may share similar ground water risks. However, this issue is not on the community's radar, so the city will have to make much greater efforts to educate and engage this community for it to effectively adapt to deteriorating conditions.

In contrast, Roxbury is one of the few neighborhoods of Boston built exclusively on naturally occurring (that is, not reclaimed) land. As a result, it faces fewer water management problems that are expected to be central concerns elsewhere in the metropolitan area in adapting to a changing climate. However, it is a less-privileged neighborhood, with a median income 25% lower than the city of Boston's, with older and more crowded homes that are less likely to have air conditioning (Boston Redevelopment Authority 2003b). Therefore, residents may be more vulnerable to extreme events such as heat waves than the more affluent neighborhoods or those located on the water. Additionally, this neighborhood suffers from exceptionally high crime rates (Boston Police Department 2008), which may undermine the ability of the local institutions necessary for emergency preparedness, such as the police and fire departments, and neighborhood associations to reach the residents. South Boston shares Roxbury's vulnerability to heat waves because it has an unusually large elderly population, with 17% of its population over 65 (Boston Redevelopment Authority 2003c). This community also has an older housing stock, but it maintains a long history of engagement with public safety, shown most visibly in the large number of police officers and fire fighters from this neighborhood. This engagement will facilitate household-level climate change adaptation interventions.

3.4 Example of Community Engagement

An excellent example of the potential for neighborhood based adaptation planning is given in the chapter on social and cultural aspects of adaptation planning in East Boston by Paul Kirshen, Ellen Douglas, Michael Paolisso and Ashley Enrici. Here they found that a group of neighborhood recent immigrant residents organized by a local nongovernmental organization were willing to attend three several hour long workshops over the space of several months to learn about climate change impacts to their community and possible adaptation options. The outside planning team presented a range of "standard" options to adaptation in the urban coastal zone. The community participants almost unanimously were able to reach consensus on the actual applicability of each "standard" option for their community and on suggestions for local variations of "standard" options. We hypothesize this is because of shared values, a history of working together with the NGO to solve local problems, and a high value in preserving their cultural and physical community. At the end of the workshop process, the community group was eager to continue with adaptation planning, which is happening with the support of the outside planning team.

3.5 Next Steps

The diversity of these neighborhood snapshots illustrate that local geographic and socioeconomic factors are extremely important to consider when designing and implementing any climate adaptation strategy. Change will only occur in these populations if these residents are incorporated into the decision-making process. The city of Boston has recognized these issues, as the Climate Action Leadership Committee (2010, p. 9) stated in its recommendations to the mayor: the city should "partner with community organizations; develop local priorities; facilitate communication; acknowledge local work; [and] create incentives for collective action." They also recognize the need to "actively engage all segments of community in design and implementation of policies and programs." The experience and local knowledge necessary to efficiently and effectively identify neighborhood issues and facilitate the required action to implement climate change adaptation are inherently community-specific. Hence, representatives, liaisons, spokespeople, and should be drawn from all affected communities.

3.5.1 Recommendations for Boston

1. Nurture and support organic, grassroots efforts to address adaptation: such efforts are not a threat to city governance but present an opportunity for action to move forward even in the face of challenges at higher levels of government.
2. When conducting vulnerability assessments, consider unique neighborhood level features, such as cultural norms and social inequity that would impact vulnerability.
3. Include specific actions, timelines, budget allocations, and processes for implementing the adaptation plan.
4. Develop indicators and budget funds for monitoring adaptation actions to ensure that goals are met and that learning occurs.
5. At the City level, utilize community advisory committee members: these advisory committee members would be ideal messengers and able to frame climate change in a way that is meaningful at the neighborhood level and help address cross-neighborhood issues.
6. Incorporate adaptation into existing planning structures and systems. One example is the BRA's efforts to put developers through a more rigorous process to ensure that they address future needs of a changing climate. Another opportunity resides in possible synergies between mitigation/adaptation and the potential to move forward with both efforts simultaneously.
7. Be aware of opportunities and necessities for taking regional approaches to certain issues that will involve several neighborhoods. As evidenced by the findings in East Boston, communities are aware of the importance of these possibilities.
8. Establish a single point of contact for each neighborhood – with the decentralization of responsibilities among the departments of the City, it is easy for citizens to be overwhelmed by where to turn for assistance. One obvious is source is the Office of Neighborhood Services.

4 Conclusion

ICLEI, Local Governments for Sustainability, describes several "best practice" stages for adaptation planning in their "Local Government Climate Adaptation Toolkit. These include plans that: "(1) Establish the context, (2) Identify the risks and opportunities, (3) Analyze the risks and opportunities, (4) Evaluate the risks and opportunities, (5) Develop options, (6) Development action/treatment plan, (7) Implement the adaptation action plan, (8) Review progress, (9) Revise the adaptation action plan, (10) Repeat." Many other climate change adaptation reports make similar recommendations (e.g., National Research Council 2009, 8, 9). Moreover, most agree "[b]cause impacts and vulnerabilities to climate change vary greatly across regions and sectors, adaptation decisions are fundamentally place-based, occurring at multiple scales…" (National Research Council 2009, 17). It follows that adaptation plans must be tailored to each scale and integrated across scales. This is a formidable challenge. It will require new forms of decision-making and new institutions (National Research Council 2009). "…[I]t is important to consider adaptation to climate change impacts as a process that will require sustained commitment and a durable, yet, flexible strategy for several decades to come" (National Research Council 2009, 10).

When considering scales of adaptation and mitigation, planners often leap from the individual household or firm to the city and then to the region and higher. The neighborhood-scale is missing in this hierarchy. Cities, especially large metropolises, are not homogeneous. Both their physical characteristics and their demographics vary among different neighborhoods. Combining these two sets of variations within a context of climate adaptation presents complex problems that have what several analysts have described as wicked properties – complexity, internal inconsistencies or contradictions, and fluidity or constant change (Rittel and Webber 1973, Brown and others 2010). Consequently, ongoing and flexible decision-making processes are important to deal with the emergent properties inherent in complex systems and wicked problems.

To evolve these processes and the institutions to implement them requires rethinking the relationship of citizens to local governments; it also requires rethinking the nature of "solutions", recognizing the iterative and ongoing adaptive responses that responding to climate change effects may require. Citizens within neighborhoods best know the political, economic, and social details of their neighborhoods and are at "ground zero" where specific climate change impacts are experienced. Decision processes and governance institutions that facilitate feedback, adjustment, and learning will better enable communities to respond to the challenges of climate change in diverse ways. An essential and critical part of this collaborative governance context is the imperative of including the wide range of interests, insights, knowledge, and experience that resides in highly diverse communities.

Many climate change adaptation reports include a recommendation to involve or consult with the public (e.g., Neighborhood Association of the Back Bay NABB 2010, 9). The City of Boston undertook one approach of public involvement by forming a citizen's advisory committee and also starting to emphasize community engagement by neighborhood. At the neighborhood-scale, a more participatory form of public engagement is appropriate, using the principles described in our Theoretical Frameworks sections and building on practices described above. A stakeholder-driven, consensus-based decision-making process is most suited to the sustained and flexible process required to make decisions in a changing climate. Chap. 20 offers an example of this sort of collaborative process, and Chap. 22 describes the underlying principles of community stewardship.

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Part IV
People and Action (Implementation and Stewardship)

Chapter 16
Introduction: People and Action (Stewardship, Community, and Implementation)

Herman A. Karl

Abstract This chapter begins by describing the role of education and lessons learned from an innovative program to build the capacity among students to tackle wicked problems. It goes on to briefly describe each of the chapters in the section developing the linkage between them that people have the capacity to change societies' relationship with nature. The first two chapters lay out a vision of community-based ecosystem stewardship. The following discusses the culture of place—how and why people relate to the place they live. The fourth chapter describes a community collaborative group that practices the concepts and principles covered in the previous three chapters. The final chapter analyzes cooperative conservation through the lens of a coupled natural and social science approach.

Keywords Ecosystem health • Relationships • Stewardship • Governance • Social-ecological systems • Collective action • Common good • Conservation

The previous two sections discussed the role of interdisciplinary research and technology and governance and policy for addressing environmental issues and restoring lands. In this section, we develop the role of citizens and communities. We set the stage by quoting at length from Holling and Chambers (1973, 13).

> But even if an ideal interdisciplinary research activity could be mobilized to produce a better mousetrap, no one would beat a path to its door. … A university can be an effective environment for research, but it is weak on the pragmatic experience required to implement it. On the other hand, institutions like government agencies, that have experience in policy formulation and implementation are so fragmented in their charge … that they are forced to concentrate on the fragments and not the whole. Neither the university nor the government

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> agencies alone can bridge the gap between abstraction and rigor on one hand, and policy formulation and implementation on the other. … In this world of increasing complexity and with the apparent need for technological expertise, it becomes massively difficult for the citizen and his political spokesman to communicate well enough so that humane controls can be applied to technology and policy. It is this gap in communication between constituencies that must be bridged if the new approaches are not to yield social as well as ecological DDTs.

As we have shown, what Hollings and Chambers recognized almost 40 years ago essentially still holds today.

The chapters in this section consider the role of federal agencies, citizens, and communities in restoring lands and ecosystem health; none of them speak specifically to the role of the university. Let's consider that role now and then I will describe briefly the section chapters and connect them to each other.

Many universities instituted science, technology, and society (STS) and environmental science/studies programs in an attempt to foster a more holistic and interdisciplinary training for students interested in environmental careers. Urban studies and planning, landscape architecture, and landscape design and ecology programs provide additional course curricula for such students. While there are more than 1,000 environmental studies/science programs at colleges and universities in the United States, many still struggle to integrate knowledge across disciplines and to graduate the problem solvers needed to tackle wicked problems (Clark et al. 2011a, b). Even if they were graduating students with the required skills, there are few career paths for them as the conventional institutions are not set up for interdisciplinary and holistic approaches to problem solving; those institutions need yet to be invented.

The editors were involved with an effort by the U.S. Geological Survey (USGS) and the Massachusetts Institute of Technology (MIT) to develop a program at MIT that would train students in the requisite skills to tackle wicked problems and bridge the gap described by Holling and Chambers. The program, MIT-USGS Science Impact Collaborative (MUSIC), was co-founded and co-directed by MIT professor Lawrence Susskind and then USGS scientist Herman Karl. Lynn Scarlett encouraged support of MUSIC during her 8-year tenure as Assistant Secretary for Policy, Management and Budget, Deputy Secretary, and Acting Secretary at the Department of the Interior (DOI). Juan Carlos Vargas-Moreno and Michael Flaxman taught courses and conducted action research in the program. MUSIC was initiated in 2004 and after a strategic review of its multi-year programs USGS ended its participation in 2010; as of this writing MUSIC continues as a MIT activity.

MUSIC attempted to integrate the work of academics and practitioners by hosting Scholars-in-Residence for stays of up to 1 year at MIT. Charles Curtin (Environmental Policy Design) was the first Scholar. Others were David Mattson (USGS) Marilyn Tenbrink (USEPA), and Olivier Barreteau (Cemagref, a French environmental organization). There proved to be virtually no interest by the faculty to interact with these expert scholar practitioners, either on an ad hoc and informal basis or through formal structured activities. We are left to conclude that the strong culture of single discipline research of the university system, the pressure on junior faculty to establish their own identity and niche, and preferences of individual faculty simply do not foster and value collaborative learning. MUSIC attempted to disseminate knowledge of the program and attract USGS scientists to participate by designating three USGS MUSIC Field Directors in each USGS region with limited success. Ongoing projects with MUSIC students were established in Central Region under the supervision of Stephen Faulkner. Keith Robinson, Eastern Region, hired a MUSIC student as a summer employee. USGS programs are not structured to support interdisciplinary research into collaborative process approaches to enhance the value and use of science in decision-making and policy formulation. Without programmatic funding, the research was not sustainable. Housed in the Department of Urban Studies and Planning (DUSP), MUSIC had difficulty in attracting students from a broad range of disciplines. Because, students were required to take a substantial number of departmental core courses, there were very few electives they could take to develop essential skills to become what were called Science Impact Coordinators. Only one recurring course was specifically developed for the MUSIC curriculum, the others already existed in DUSP. Students were required to participate in a multi-semester field project with agency personnel. Students in the program needed to be grounded in a specific discipline, which could be physical science, biological science, social science, political science, etc., and to work in an interdisciplinary context. MUSIC attempted to teach five basic skills or core competencies: (1) ability to engage a range of individuals or groups in problem solving, (2) ability to reframe policy choices or courses of action, (3) ability to do social and political mapping and conduct a stakeholder assessment, (4) ability to synthesize and not merely compile information, and (5) ability to develop a common functional language that diverse actors could use to communicate. Students must think critically with open minds to attain these skills, which are minimal core essentials for organizing and facilitating people and communities in a deliberative, participatory process that fosters decisions made in the *common interest* and for the *common good*.

A lesson learned from the MUSIC experience is that champions in leadership positions are necessary to institute such unconventional and progressive programs. A second lesson is that these programs require a significant investment in time and resources both financial and personnel. Third is that new standards of accountability are necessary to evaluate progress and success. And a fourth lesson is, even with champions, the institutions supporting these programs themselves must be progressive and unbound by convention to sustain the program. Once the champions leave if the institutional environment is not conducive to taking risks and breaking down walls, the program is bound to fail. Individuals within USGS and MIT made a sincere attempt to support and grow MUSIC. But there are strong barriers between departments at MIT as there are strong barriers between disciplines at USGS. Institutionally, neither organization is structured to support a program that unifies knowledge across disciplines and engages in long-term deliberative processes to solve problems. MUSIC was progressive in responding to the call from many advisory panels (National Research Council 1995, 2008, 2009) to conduct interdisciplinary research and develop collaborative approaches for dealing with environmental issues, but in its first 6 years, could not surmount these barriers.[1] Most of all, academe and the agencies need to guard against relabeling old activities with new names that continue to function as they had only now masquerading as something else.[2] The chapters in this section (and all in the book) implicitly if not explicitly make a strong case that skills and approaches such as those MUSIC endeavored to instill in students are needed to move environmental policy formulation and land management away from "…the sad spectacle of one obsolete idea chasing another around a closed circle" (Aldo Leopold in Meine 1988) toward action and to provide for people's needs.

Section III ended with a chapter on exploring the role of the neighborhood in adapting to climate change in an urban environment. In this section we expand the discussion of the role of people and communities in restoring and sustaining lands. Keep in mind that we embrace the larger concept of community of Leopold's land ethic, which includes "… soils, waters, plants, and animals, or collectively: the land" (Leopold 1949, 204). Fittingly, this section begins with Chap. 17, *Community-based Ecosystem Stewardship: A Concept for Productive Harmony on the Public Lands of the Western United States*, by Gary McVicker that develops the relationship, which includes stewardship and governance, of humans to nature.

McVicker provides a comprehensive overview of what he calls "Community-based Ecological Stewardship" for the public lands of the western United States, which have long been the center of many national controversies. He presses the case that to restore ecosystem integrity to the public lands, the idea of productive harmony (as defined by the National Environmental Policy Act) must be pursued where a clear connection between people and the land still exists – locally, at the community level. He describes a process of science, citizenry, and government coming together in a relationship that extends knowledge and power of choice downward and outward to citizens, rather than relying on current formal systems for seeking citizen input in government decision-making. In his view, collaboration begins through building local consensus on common objectives, but then must be continuously pursued on multiple fronts, with bureaucratic barriers yielding to and supporting local empowerment. He proposes a set of principles that he believes are needed to assure that the tenants of good government and responsible land stewardship are adhered to in that process. McVicker sees the process, when properly applied, as one that might ultimately help resolve the human conflict with nature on a much larger scale. However, he recognizes that there are many challenges to making that

[1] We do not comment on or evaluate the success or failure of environmental studies/science programs at other colleges and universities. We talked about MUSIC specifically because it was a federal agency/university partnership that involved the four editors in various capacities. MUSIC was part of the USGS Science Impact Program; that program has ended.

[2] "How many universities have relabelled [sic] old boxes with 'Faculty of Environmental Studies?' How many governments have recycled existing activities into 'Departments of the Environment?' Such steps might lead to new panaceas that are more disastrous than the old because they are more global" (Holling and Chambers 1973, 13).

a reality and goes on to address in considerable detail those that apply to the public lands. Unlike the conventional academic paper, McVicker does not cite other sources. His ideas are the culmination of his professional life and experiences coupled with a long-standing concern over the human impact on nature. There is strength and authority in this personal narrative. Like the rest of the chapters in this section, it is a manifestation of having been in the arena (see footnote 8, Chap. 1). He concludes with a provocative question: “No doubt, there are many beneficiaries of what is now in place that will resist such change, but should proponents (beneficiaries) of the past decide our future?”

In Chap. 18, *Thoughts on How to Implement Citizen Based Ecosystem Stewardship from 32 Years in Governance*, Richard Whitley provides a similar perspective to McVicker’s narrative. His experiences are based on a 32-year career with the Bureau of Land Management. Like McVicker, Whitely’s on-the-ground experience has instilled in him an intuitive knowledge of what works and why it works.[3] He identifies the barriers and challenges inherent in the current institutions that impede change in the system. Whitley recognizes that science is value-laden and that decisions based on the best science (defining “best” is a source of conflict in itself) do not guarantee that the decision is right or wise. In recognition of this, he emphasizes the importance of relationships. In a collaborative process it is important to recognize other viewpoints as legitimate even if you fundamentally (and perhaps viscerally) disagree with them; those around the table must respect each other’s differences. Out of this respect and recognition of legitimacy of other perspectives comes trust. The Interagency Cooperative Conservation Team (on which Whitley and Karl served for 4 years) visited many collaborative stakeholder groups around the country. Without exception, every group said they could only work together because they learned to trust each other. Trust can take years to develop and is fragile, if broken the group may unravel. Whitley tells a metaphorical story related to the Interagency Conservation Team by an Arizona rancher. The rancher explained how he used to “break” horses in his youth using the brutal methods acceptable at the time. He then

[3] Every field scientist knows this. It is not to say that definitive answers come from only observations in the field and not from scholarly research. Perspectives different from those of the scholar are arrived at. If scholarly analysis could be combined with practical experience, new insights would be gleaned through integration of scholarship and practice beyond those attained by the scholar and practitioner alone. This would, of course, require not only communication between the scholar and practitioner but also mutual respect. It is a laudable scholarly trait to be aware of the relevant literature and to cite it extensively. It is impossible, however, to have critically examined each article and book when many score and even hundreds are cited, particularly when research assistants are relied upon to cull through and summarize the literature. And without critical analysis there is danger of perpetuating dogma (the peer review system is not fail safe and most books are not blind peer reviewed). Far better to cite fewer references that are thoroughly analyzed and vetted than many that are by-and-large taken on face value as authoritative. In this way a system of checks-and-balances is set up to the advantage of both the scholar and practitioner communities; our understanding and interpretation of complex issues is more nuanced and knowledge, not dogma, more likely to be advanced.

explained that now he uses behavioral techniques to bond with the horse. He said that both methods get the results he wants. The big difference, however, is that he never knew when the horse broken by the old method would turn on him – neither trusted the other; in contrast, he had built a relationship based upon trust using the behavioral training method and he was confident that horse would never turn on him. Policy formulation and implementation may be more effective by working with people to build a trusting relationship.

Chapter 19, "*Climate Change and the Language of Geographic Place*," by Jim Kent and Kevin Preister, introduces the perspectives of the social scientist to community-based ecosystem stewardship. In Chap. 1 we stated that a new ethos is necessary to achieve harmony among ecological, social, and economic systems. The seeds for that ethos will be sown at the grass roots level and it will sprout in many communities and places across the globe. As Kent and Preister point out, national and international strategies and "blue prints" laying out how to deal with climate change are "top down" driven and do not take into account "… the social cultural, and economics of everyday people who are being impacted by these policies." The culture of place is very powerful.[4] Human Geographic Mapping by Kent, Preister and their colleagues takes into account how people actually relate and identify with their landscapes, reflecting the natural boundaries within which people communicate and take care of each other. When policies reflect these boundaries and the activities occurring within them, they become an effective vehicle for positive, adaptive change. Moreover, they make the case that positive measures to address climate change must be occurring at a local level before aggregated actions at higher geographic scales can be successful. These features of informal community systems operating to take care of the land and the people are usually not used or understood by policy makers and natural resource managers. Understanding how people relate to the place they live should be routinely part of environmental policy design. Kent and Preister describe a process for grounding policy initiatives geographically by understanding the language of place. They assert that citizen-based stewardship is the key for adapting to climate change and, by extension, achieving sustainability.

Chapter 20, *The Tomales Bay Watershed Council: Model for Collective Action*, by Pileggi, Carson, and King demonstrates the power of citizen-based stewardship and is *the linchpin that ties together the other chapters in this book into a functioning*

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[4] Kent, Preister, McVicker, and Karl were instructors in the BLM Community-based Ecosystem Stewardship course. One of the workshops was held in McLaughlin, Nevada. Most of participants were coming from Bullhead City, Arizona a small ranching town just across the Colorado River from McLaughlin, a casino town. We had an advance registration of about 45. The first morning of the workshop only 8 participants showed up. We had to cancel the workshop. Kent and his colleagues had mapped a cultural boundary through the Colorado between Bullhead City and McLaughlin. We can only speculate that the Bullhead City participants did not cross the cultural boundary to attend a workshop in a Nevada casino. Had the workshop been held in a community center, or school, or firehouse, the usual places for the workshops, in Bullhead City we suspect that those registered would have participated. But we can only speculate.

engine of action. The Tomales Bay Watershed Council (TBWC) operates on a consensus-based decision process that involves all stakeholders in the watershed that would like to participate. It is a model of a place-based, collaborative approach to watershed stewardship; it coordinates science, politics, and people for action to manage ecosystems and restore and preserve lands. Yet, as you will read it is a difficult task and not accomplished without challenges. I visited the TBWC in about 2002, 2 years after it had started. I was speaking to the group about joint fact-finding – part of a consensus-based process that involves scientific information. Two things are embedded in my memory: (1) I was asked by Ellen Strauss, a key figure in the local dairy industry, if I was there to tell them what to do; the answer was "no", I was there to learn from them; and (2) the group had formed out of a conflict over oyster contamination and after solving that conflict expected to disband – however, they realized that conflict never goes away and that they needed a process that allowed them to make decisions in the face of ongoing conflict. As you read this chapter, pay particular note to the relationship with the federal, state, and local governmental agencies. Many agency personnel choose not to participate in consensus-based collaborative processes because they claim (falsely) that they are being asked to give up decision-making authority that is mandated to them by statue and law. This is not accurate. In a well-designed consensus-based process, they are being asked as equal participants to make the decision reached by the group. The TBWC recognizes this: "Indeed relevant agencies *must* also participate in this process on the same level as other stakeholders. Mandated by law, they are the guardians of the practical constraints to ecosystems." The Interagency Cooperative Conservation Team visited the TBWC in 2003 to learn about its process and approach to conservation. As have other chapters in this book, this chapter concludes poignantly with the recognition that we (people) can make a choice: "We may continue on the path to extinction. Or we may well be at the threshold of a path to new possibilities, creating innovative and holistic ways of thinking and of being. … Ultimately, the choice is ours."

In the last chapter in this section, *Outcomes of Social-Ecological Experiments in Near-shore Marine Environments: Cognitive Interpretation of the Impact of Changes in Fishing Gear Type on Ecosystem Form and Function*, by Curtin and Hammitt, we examine another form of participatory conservation that couples the intersection between human perception of change and the role of alternative fishing strategies in influencing ecosystem composition and resilience. This chapter is an output of the MUSIC program. Charles Curtin was the first MUSIC scholar-in-residence who over the course of several years taught a range of courses at MIT from collaborative and adaptive management (with Herman Karl), to landscape ecology and complexity and policy design. The complexity course led to a forth-coming book to be published by Island Press. Curtin has nearly two decades experience developing place-based conservation and large-scale research projects in marine and terrestrial ecosystems spanning North American, East Africa, and the Middle East. He has recently founded the Resilience Design Group at Antioch University in Keene, New Hampshire that focuses on applying resilience and complex system theory to environmental and social problem solving. Sarah Hammitt was a student in the MUSIC program and chose the topic of the chapter as her required field project under Curtin's supervision. This chapter is a strong example of the scholar practitioner approach for analyzing a case. Curtin has an academic background in ecology and social-ecological systems. He is akin to an anthropologist in that he lives in the communities in which he conducts his studies. He associates with the people in these communities on a daily basis, many of them are his friends, his children go to school with their children; his family is part of the community. Yet, he uses rigorous scientific methods in his action research. He develops both an intuitive and scientific understanding of the social-ecological system and he is able to get "under the surface," which enables an understanding unlike that either the scholar or practitioner could obtain working independently. The Maine fisheries case, although an investigation of a particular place, scale, and time, provides general lessons about the response of cultural (social) systems and ecological systems to disturbance and the resilience of those systems to change. The chapter is an example of the coupling (a true integration) of natural science and social science approaches to tackle wicked problems; many reports cite interdisciplinary integration between the natural and social sciences as necessary to deal with adaptation to climate change.

The theme that unifies these chapters is the belief that people and communities have the capacity to change our relationship with nature – to develop a new environmental ethos. Environmental policy and natural resource management should be a collaborative effort between citizens and government. This will require experimentation with new forms of governance as discussed in Section III and new approaches to utilizing science and technology as discussed in Section II. It will require acknowledgement that current institutions and ways of formulating policy are not adequate to deal with the continuing and increasing conflict around ecosystem management and land restoration especially in the face of rapidly changing climate. It is people and not governments that will force the necessary changes. As in all social movements, people initiate action. Politicians follow and ultimately enact the laws that are necessary to support and enforce social change before there is general acceptance by the citizenry. Yet, these laws are not sustainable unless there is a fundamental change in societal culture; development of a new ethos takes years and perhaps generations. The civil rights movement in the United States is a case in point. There is no better way to end this section introduction than by combining concluding statements from Chaps. 17 and 20: *No doubt, there are many beneficiaries of what is now in place that will resist such change, but should proponents (beneficiaries) of the past decide our future? Ultimately, the choice is ours.*

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Chapter 17
Community-Based Ecological Stewardship: A Concept for Productive Harmony on the Public Lands of the Western United States

Gary McVicker

Abstract Productive harmony and ecosystem management were introduced to public land management through law and policy over the last 40 years. Neither has been successfully implemented over large areas. The challenges are complex and varied, but ultimately come down to social and political factors that either have not been considered, or if they have, resolved. Challenges faced by agencies are examined, and a new process proposed that fundamentally tests the status quo, socially, scientifically, and institutionally. It would empower people to find solutions, using science as a foundation, while adhering to principles of good governance. The process may have broader application than just public lands.

Keywords Sustainability • Ecological stewardship • Public land management • Ecosystem management • Productive harmony • Ecosystem integrity • Community-based stewardship • Place based stewardship • Role of government

> If there is to be an ecologically sound society, it will have to come from the grassroots up, not from the top down.[1]

1 Introduction

The history of public lands and their management can be seen as an evolution in democracy. Their original acquisition had nothing to do with what we now think of as "the public lands" (National Parks and Monuments, Wildlife Refuges, National

[1] Paul Hawken, *The Ecology of Commerce.*

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Forests, BLM lands, etc.). It was about manifest destiny, the idea of making this once vast expanse of unsettled, wild land available to people so they could build wealth, communities, cities, and ultimately a nation that spread from ocean to ocean. Along the way another vision came to bear, that leaving some of this land unsettled and in a more natural state was, in itself, of value to society and the nation. So it came to be, first a reserve that later became a national park, then a wildlife refuge, then the national forests, and so on, until by the early part of the twentieth century we had reserved the majority of what we have today as public lands. Agencies were established to manage these designated lands. Each was given a mission different than the other and expected to manage its piece as a trained, professional organization.

There was an unsettled issue from the beginning, however. On one side there was concern for the sanctity of nature, on the other, the idea that land must be put to beneficial uses to serve the economy and society. Both views had their proponents, but it was the latter that largely held sway in the early days. Not for long though. By mid-century the public began to have enough free time and mobility to start exploring the public lands. That, along with the fact that society was becoming more environmentally conscious, soon led to a host of laws affording new protections over these lands, and assuring greater public involvement and oversight in their management. The agencies began losing much of their former independence. The stage was set for decades of social, political, and legal struggle that further defined the nation's desires for the public lands. That struggle goes on even today, and in fact, seems only to have become more political and divisive than ever.

Perhaps it's because some people are tired of the fight, or that they've lost faith that lasting answers will ever be found by working through government alone; whatever the reasons, a new but still largely undefined relationship between government and citizens may be developing at the grassroots, one that might very well point to deep and fundamental change in the future of public land management, and once again, help to redefine democracy itself.

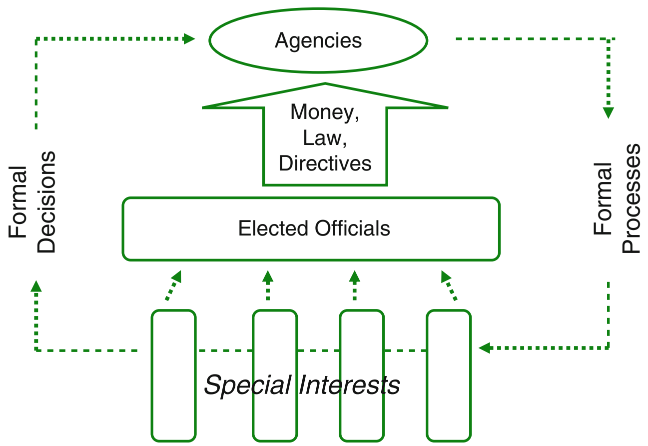
In this paper, the author explores public land management in the context of ecological stewardship, a condition of shared and empowered responsibility between citizens and government operating at landscape scales. The challenge might be summed up as: *Fostering a social and informational environment at the community level supportive of a continuing, collaborative relationship among scientists, government agencies and citizens, inclusively, to define and pursue a condition of landscape ecological health that is naturally sustainable and both supportive of, and supported by, desired economic, social, and cultural conditions and values.*

2 Part 1: Public Land Management – A Study in Complexity

The public lands have always served as a nexus for debate concerning the human relationship to nature. Even a 100 years ago there were those who argued that the public lands should serve as a sanctuary for nature, but others held that they should be put to beneficial uses and managed under principles of sustained yield. Still others held an even more extreme view, that these lands were only a vast store of natural resources that should be made available for people to explore and develop at will. Essentially these same arguments define society's struggle over public land management today. Throughout their history, the public lands have served to reflect and define the different values toward land and nature represented in American society. The different missions given the agencies responsible for managing the public lands largely reflect those same competing societal values.

In recent years, these value-laden debates have seemingly become even more polarized and politicized. It is not uncommon for agencies to experience opposite direction from one administration to the next concerning public land management. Even those agencies that have enjoyed some degree of insulation from these extremes no longer do, and now find that they too must administer their land base with greater deference to competing ideological directions, rather than through knowledge gained as professional land managers. For some, the resulting loss of clarity in mission may even be affecting morale.

Dealing with conflicting demands is not a new challenge for public land managers. Most of the procedures needed to arrive at fair and balanced decisions have their origins way back in the 1960s and 1970s, when a host of new laws were enacted in response to growing environmental concerns. At the same time, other laws were made to assure equal and open access to the plans and decisions being made by public land agencies. Accordingly, formal processes for public involvement were implemented. Since then, however, a wide range of other influences has come to bear on those formal planning and decision-making processes, with the result that a seemingly ever growing and more complex array of influences now affects public land management, as the following model illustrates:



2.1 Model 1

In this model, special interests are shown as organized and competitive. Each is capable of exerting influence through the formal processes of public involvement for planning and decision-making, as well as through political channels that can influence the directions set by congress through the appropriations process. This model is, by design, simplified to serve discussions as we proceed through this chapter.

This model represents a highly evolved system of checks and balances to deal with the many diverse values and demands directed toward the public lands. It is an inclusive system, one that assures equal access to the formal processes of government, namely planning, environmental review, and decision-making, by all concerned interests. The model also represents the power systems, however, such as organized special interests, businesses, and industries that compete for that decision space not only through the formal process of government, but also through Congress and other points of influence. Thus, although largely designed according to principles of good governance (e.g., inclusiveness, openness, effectiveness, accountability, etc.), the system remains vulnerable to the demands of self-interest.

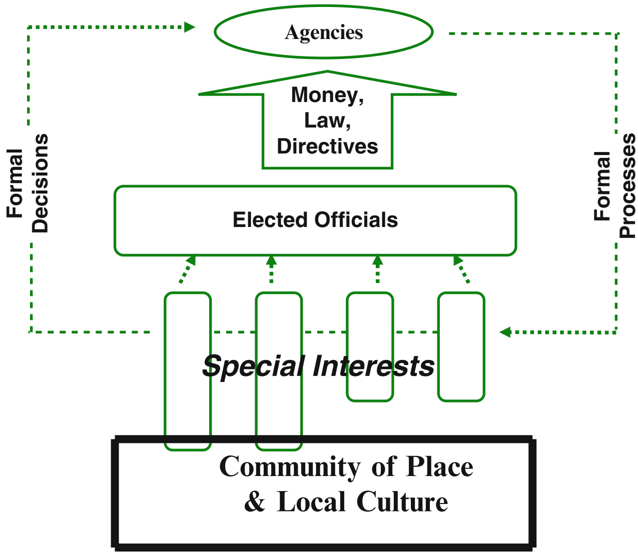
The term "community" is used in everyday conversation, but how well is it understood? Most sociologists see it as cohesion among people based on common need, purpose, or identity, a definition that certainly applies to the special interests shown in the model. In fact, another term often used for these organizations is "communities of interest." These communities tend to be vertically organized. As implied, they represent the interest(s) or concerns of their members, who are often widely dispersed, socially and geographically. It is largely the strength of that membership that determines the organization's ability to influence public land management.

Communities of interests are functionally and organizationally very different from another kind of community – "community of place." Communities of place organize and function horizontally, not vertically. Information moves mostly by word of mouth through a wide range of social settings – church, gathering places, businesses communication, special events, etc. Unlike communities of interest, membership in communities of place can be rather exclusive and difficult to become a part of, especially for outsiders. Even newcomers involved in the same kinds of businesses that typify the area, such as ranching, can find it hard to become accepted and trusted in some of these communities.

The norms and standards for both thinking and behavior can be rather rigid in communities of place. Even local businesses and governmental entities can be expected to show their support for prevailing attitudes and values. If change is to come, it normally has to come from within, through the careful processing of new information, or by insiders themselves challenging established power and belief systems. Seldom does change come through the concerns and influences of outsiders. Resistance is often the norm.

So, when it comes to managing the public lands, there is far more at play than what was illustrated in the earlier model. Although much influence comes through the interactive processes of government and formal organizations, it is at the local level where the success or failure of decisions and initiatives is often determined. This critical interface between the vertical systems of governance and horizontal systems of place is perhaps the least understood, or even disrespected, factors of public land management. No formal process has ever been designed to manage this interface, nor would any suffice to do so.

Communities-of-place have another attribute that is important for consideration, culture. Culture is one of the human attributes most responsible for our success as a species. It is largely through culture, and our ability to pass it from one generation to the next, that we have been able to adapt to such a wide range of environments across the planet. In modern America, culture is defined in many ways, but seldom in terms of the land-based cultures that still lay on the land like a patchwork quilt. Nevertheless, it is those cultures, and their relationship to communities of place, that must be included in our model if the picture is to be made whole.



2.2 Model 2

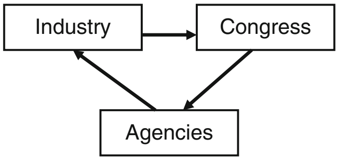
This second model indicates another situation worth noting; some special interests (i.e. communities of interest) are not likely to be socially or culturally connected to the community of place, even though they may have members living there. This is especially true in many rural western communities with a history of resource dependent economies. For the most part, special interests that are well connected to community of place are those viewed as economically important and/or culturally aligned, while those not connected are considered either unimportant, or even a threat.

Many people in the social and cultural networks of place do not engage in the formal processes used by agencies for public involvement. They tend to rely, instead, on political representation to protect their interests. What contact does occur between agencies and these local people is generally by agency personnel through related programs, such as grazing and forestry. So although this critical juncture between government and the social and cultural networks of place may in fact be joined, the interaction remains rather limited in scope and purpose.

Nor is there much opportunity for contact or meaningful communication among special interests and people of place. Formal processes are generally not designed to bring these people together in a manner that leads to collaborative relationships. Although they may come together through specially arranged meetings or field tours, these happenings are mostly too brief to support the deep dialogue needed for mutual understanding and consensus. This failure to effectively exchange information may only serve to maintain the distrust and fear held by one to the other.

Formal processes may also have had some unintended consequences. Because government holds the decision space, participation can be more about competing for one's own part of the decision, rather than working with others to find solutions of more common interest. And, since the formal processes themselves are typically designed around agency programs (i.e. grazing, forestry, wildlife, recreation, etc.), they may be seen as serving the agency's interests, more than that of the locals.

There is yet another factor that is not well depicted in the model, the influence of corporations and industries. The once dominant view that much of the public lands should be used for economic purposes has often resulted in a strong alignment among local interests, corporations, agencies and Congress, particularly where high value natural resources have been involved.



Over the course of the last century, the utilitarian view has gradually yielded to other values society holds for the public lands, but often only after legal challenges largely based on data provided by the natural sciences. Nevertheless, the utilitarian view remains a strong social and economic factor within many communities of the West. Many communities still rely on traditional resource based industries, such as grazing, mining, energy, and logging. But now there is an array of recreational activities on the public lands associated with their own industries (e.g., mountain biking, ATVs, hiking, climbing, etc.) Even more recently, alternative energy sources, such as solar and wind, have grown as yet another industrial influence over the public lands. So the relationship depicted by the previous diagram remains relevant today.

Corporate and industrial interests associated with all of these economic activities, both traditional and new, may enjoy a significant amount of influence within the system being discussed. Many of them are viewed as important not only to the local interest (i.e., jobs, economic development, etc.) but the national interest, as well (i.e., energy, timber, etc.) How they are seen locally, however, may vary significantly both from within the local citizenry and from community to community. There are some desert communities, for example, that are quite concerned about the impacts to local landscapes if large-scale solar or wind energy projects are approved. In other communities, intensive fossil fuel development (oil and gas, and even oil shale) is stirring a great deal of local controversy. In some cases, interest groups once on opposite sides are now uniting to resist these national initiatives.

When considering all these many variables and influences in public land management, one might view the system as completely unworkable. To some extent that might be so, but if there is one most important element in making it work, it is the dedication and professionalism of the people in the natural resource agencies themselves. Without them the whole thing would surely dissolve into chaos. Still, the question must be asked: Is there a better way forward from here?

In spite of all its faults and complexity, the past 100 years of public land management has served as an important venue for advancing the principles of democracy and good governance. Nevertheless, the resulting system, as should be clear by these discussions, does have serious shortcomings. While the system has managed to bring forth many public land management issues and concerns before society for deliberation, by no means have all of these been resolved in ways that might pass the test of professional and responsible land management policy.

Perhaps the system's worst characteristic is that it grew out of reductionism. The public lands have been divided among different agencies and programs, often according to competing interests within society. At smaller scales, the land is divided by fence lines demarking different grazing allotments; by different legal designations, such as wilderness and national monuments; by administrative boundaries within in the same agency; by political boundaries; and by differing land status resulting from private settlement and other land disbursements. Reductionism may offer advantages for efficiency and organization, but for purposes of managing land in the interest of natural systems and human culture, it presents serious limitations.

3 Part 2: NEPA and the Pursuit of Productive Harmony

The idea of "Productive Harmony" was established in law under the National Environmental Policy Act (NEPA) of 1969. Section 101 of that Act states, in part: *The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, …declares that it is the continuing policy of the Federal Government, … to use all practicable means and measures, … to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.*

In a sense NEPA recognized the tension that had surrounded public land management from the beginning, the sanctity of nature versus economic use and development of natural resources. The Act did not offer solutions, but it did set the stage for a deeper and more informed exchange of information between government, science, and citizenry concerning the environment. It was hoped that this exchange would help move society toward a more common understanding of the environmental issues we face, and ultimately toward better choices and decisions. To some extent, those hoped for outcomes have been accomplished. However, many of the same old tensions among competing interests are still there, and a sustainable relationship between humans and the natural world remains only an ambition. Indeed, in those 40 odd years since then President Nixon signed NEPA into law, we have gone from environmental issues of mostly local concern, to global.

For the most part on the public lands, government has done a commendable job of meeting its procedural requirements under NEPA, at least as it concerns impacts associated with individual projects and proposals. The same cannot be said for another of the law's provision however, that cumulative impacts should be addressed in the larger contexts of area and time. While a single action may prove to be insignificant in terms of its own impacts, similar actions taken over a larger area, or a longer time, can have significantly greater detrimental effects upon natural systems (ecosystems). These cumulative impacts will not be evident unless this broader assessment is made. Approaching public land management through a wide variety of agencies, programs, issues and interests – a consequence of reductionism – must be considered a major cause for the inability of government to more effectively meet this provision of NEPA.

Section 101 of NEPA poses still another challenge: *In order to carry out the policy set forth in this Act, it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may fulfill the responsibilities of each generation as trustee of the environment for succeeding generations…* According to this language, the responsibility of government does not stop at merely documenting the anticipated environmental impacts of proposed actions: it calls for a continuing exploration for any and all effective and practical means for attaining the social, environmental, and economic outcomes stated in the Act. Has government done that, or has it become trapped in the legal drudgery of environmental reviews? Arguably, it is very much a case of the latter. The creativity otherwise called for by NEPA has largely been ignored. The problem has been helped along by the countless legal challenges brought against agencies over the years. Nevertheless, it may be time to unleash this creative part of NEPA and breathe new life and energy into the quest for productive harmony. The challenge still stands before us today.

4 Part 3: Ecosystem Management

As a society, we have traveled a long road of changing values and attitudes concerning public land management. Early on, we tended to use the powers of government to approach their management according to the prevailing agrarian values of the time. Agencies worked to get rid of those parts of nature (predators, unwanted plants, etc.) considered competitors to our own interests. Efforts were even made to convert whole ecosystems to pasturage for livestock, or near monocultures of specific timber species. Some of the same thinking was applied to, in theory, optimize those species wanted for hunting and fishing. As a result, situations arose in which entire populations of game species collapsed due to overpopulation and habitat destruction.

Although there were those who tried to tell us so from the very beginning, only gradually did we as a society learn to better understand and respect natural systems for their own right. It wasn't until the middle part of the twentieth century that enough people, believing that the public lands should be managed more in a natural state, gained enough political strength to affect change. Most of the now familiar environmental laws soon followed. Still, various agencies continued to mostly serve the natural resource based industries, often with the same practices that were used earlier in the century. It seemed that the only way Congress and the agencies had to satisfy the disparity in societal thinking was to designate parts of the public lands for one value or the other (wilderness, national parks and monuments, multiple-use, etc.), a process leading to even more reductionism. By the late 1980s a new idea for managing natural resources was gaining momentum; ecosystem management, a concept that potentially had far reaching implications for the public lands.

Much has been written on ecosystem management, including many definitions. For purposes of this discussion, ecosystem management is defined as: *Restoring and maintaining the natural integrity and function of ecosystems, consistent with compatible and sustainable social and economic conditions, through shared vision, common purpose, and collaboration.* Although this definition is the author's own, it is largely a synthesis of other definitions and concepts already widely accepted.

Ecosystem management challenges natural resource management agencies, methodologies, policies, and institutions, as well as society itself, to change rather dramatically from where they have been, and to a large degree, where they still are today. No longer is public land management about individual agencies acting alone. They must become more collaborative, not only with each other, but with the public as well. Nor is further reductionism of the public lands any longer appropriate. Holism is called for – economics, social considerations, and natural systems all included in a model of compatibility and sustainability. Most importantly, and most demanding of all, ecosystem management asks that we learn to share common understanding and purpose in our relationship to nature, and possibly to even shift our economic models to the extent necessary to do so.

Ecosystem management is founded on the new paradigm of sustainability. It calls less for our setting nature aside than it does our learning to become interactive with it in ways that support the natural systems we are so dependent upon, while allowing the human endeavor to proceed.

Ecosystem management was deeply explored by public land management agencies, universities, and various think tanks during the 1990s. Some progress was made toward its implementation; superficial progress, to be sure, but progress nonetheless. In the author's opinion, much of that momentum was lost in the first 8 years of the new century. Public land management actually returned to a more top-down, hierarchical approach to management, particularly as it applied to fossil fuel development. In response, citizen interest in having more local say only grew during those years.

Now days, we seem to be returning to the idea of ecosystem management, but the concept may still be compromised by top-down initiatives aimed at using the public lands to help solve the nation's energy problems, this time not only with fossil fuels development, but alternative energy too. This paradox will likely continue until a national energy policy is formed; hopefully, one that relies less on the public lands as a solution, and more on distributed energy and energy efficiency initiatives in already existing towns, cities, and infrastructure.

We are still politically trapped in our old economic paradigm of "more" – more land, more resources, more energy, more people, and more consumption needed to fuel an ever enlarging gross national product. It seems impossible to have a meaningful dialogue concerning sustainability as long as the politics of Washington are driven by these assumptions.

Ecosystem management cannot be effectively pursued on the public lands as long as top down decisions are made that threaten or defy local knowledge and sentiment. Doing so puts the vertical power systems of government in conflict with the horizontal social/cultural systems of place. If ecosystem management is to be given an opportunity to succeed, it needs to be moved down to a less ideological level of society where people can focus more on their relation to each other and the land, qualities often found in communities of place. As will be discussed later, doing this requires that we fundamentally rethink the role of government, and how natural resource agencies go about managing the public lands.

Other Concerns for Ecosystem Management: In recent years, there have been several high profile actions taken by government in the name of ecosystem management that may have affected the underlying social and political support needed for the concept to succeed. These initiatives involved the reintroduction of two of North America's most controversial predator species, grizzly bears and wolves (both Northern Gray and Mexican wolves). In biological terms, restoration of these species over much of their former ranges and habitats is proving quite successful (with the possible exception of the Mexican wolf), but at what cost? Ecosystem management calls for us to not only consider the biological challenges, but social and political ones, too.

Although the author very much favors their reintroduction, these animals do evoke deep divisions within our society, particularly in the West. On the one side, there are those who believe these animals are essential members of the ecosystems they formerly occupied. That is, they are not just nice to see, but essential to the overall health and functionality of these ecosystems. Other people see them as not only unnecessary to the land, but as threats to local people and economies. Obviously, there are other views in between these, but these essentially frame the outsides boundaries of the issue.

Prior to retiring, the author spent a few years serving as part of a team that put on ecosystem management workshops around the West. In total, some 30 communities were visited, with both citizens and government officials present at each location. It was not uncommon for someone from the local community to ask about wolf and grizzly reintroductions, or about other initiatives they interpreted as being part and parcel of ecosystem management. These questions were posed out of a concern and fear that government and outsiders were imposing their will over the locals.

In one location the divisions were so deep within the community itself that meaningful dialogue was impossible among its own citizenry. Fear and ignorance controlled the interaction among people. A local storeowner said that if she became known as someone who favored wolf reintroduction, it would destroy her business. Nevertheless, in this heart of Mexican wolf country, we managed to open up the dialogue among the people present, and with amazing results.

At first, people were absolutely against the idea of openly talking about local wolf reintroductions. But soon that reticence was transformed into a rich civil dialogue of ideas, values, and real information. Ranchers, government people, environmental interests and business people were all involved. Some even returned the next day to share input from people they had consulted with overnight in their own social networks. In the end, one person who had earlier said, "I can't imagine anyone in their right mind thinking it is a good idea to reintroduce wolves, " changed to; "Well, I did learn something; we need to listen to each other." In response to that person's earlier statement, someone informed her that it had already been shown that the presence of wolves discouraged grazing in riparian areas, thus benefiting the productivity of the entire ecosystem. In just a few hours, more real information concerning wolf reintroduction was exchanged among the people in this community than had happened in a year, or more.

In another location in New Mexico, one old-timer rancher came to the meeting literally talking of going to war. Three days later he was heard to say, "I think we need to become ecosystem managers."

There is another dimension to this story, however. In the 1990s, the government effectively empowered citizens to work through the many issues associated with reintroducing grizzly bears in an area overlapping several states. After months of work and consensus building, a plan for the bear's reintroduction finally emerged as a citizen/community-based effort. Then an election brought about the familiar ideological change in Washington. A short while later, a governor from one of the states involved stated, "Those blood thirsty animals are not going to be released in my state."

The point that should be drawn from these experiences is that ecosystem management must be approached locally through an empowered, inclusive, and well-informed dialogue. Ideologically driven political decisions, from either side of the political spectrum, or other forms of top down government decision-making, will not serve ecosystem management. Such acts often only deepen the divides among us, and foster even more local distrust of government and "outsiders."

There are plenty of people who locally recognize and understand changes in society's will toward the public lands. If given a chance, they are willing to serve that larger will, but in a manner that provides for their own interests as well. Ecosystem management demands that the power of choice and problem solving move downward to these reasonable and responsible people, not away from them. Self-interest must enlarge to encompass the larger whole; otherwise, it will remain competitive, or even combative.

Some Challenges to Restoring Ecosystems: There are many social, political, and economic challenges to ecosystem management. Concerning natural systems, however, the challenge facing us is summed up in the following definition: *Ecosystem Integrity – the ability of ecosystems to sustain natural ecological processes over time, optimize energy capture and nutrient transfer, maintain viable populations of native species with genetic diversity, while providing natural goods and services to human kind.*[2]

It would be far beyond the scope and purpose of this chapter to attempt a full discussion of ecosystem integrity. However, some basic background is important to a more complete understanding of ecosystem management and related concepts to follow, later on.

The term ecosystem generally refers to a distinct "community of organisms" (i.e., plants and animals). One ecosystem is distinguished from the next primarily by the associations of species present. For example, in the West, pinyon-juniper woodland is ecologically distinct from a Ponderosa pine forest, even though they are both coniferous forests and often located adjacent to each other. Each of these ecosystems is highly adapted to the environments it occupies, as determined by such factors as elevation, soils, and climate.

Individual ecosystems typically provide habitat for a host of different species, as compared to another. As a simple illustration, pinyon-juniper woodland hosts the pinyon jay, while the related but quite distinct Steller's jay is typical of Ponderosa pine ecosystems. Individual species can be highly adapted and limited to the ecosystems they are associated with, so much so, in fact, that they may lack the ability to readapt to other systems.

Healthy, intact, and functioning ecosystems provide a wide variety of services, including: moderation of climate and climatic events, such as floods; soil building; capturing, storing, and recycling nutrients; providing a variety of foods and medicines, many potentially yet undiscovered; and perhaps most fundament of all, performing photosynthesis, a process that converts solar energy, water, and carbon dioxide into chemical energy, the stuff upon which all life on earth depends. In performing photosynthesis, excess carbon is removed from the atmosphere and stored as plant, microbe, and other living material. The more robust ecosystems are, the more services they can provide.

Various plant species perform photosynthesis using different chemical pathways designed to be most efficient during changing seasonal and climatic conditions (i.e. variable moisture, temperature, solar intensity, etc.). In addition to using differing chemical pathways, the physiology of different species is designed to support photosynthesis under variable conditions. For example, the pores (or stoma) of one species might be better adapted to preserving the plant's moisture during stressful climatic conditions, while another's may be designed to optimize the exchange of water vapor and gases associated with photosynthesis during more favorable climatic conditions. This is only one example of physiological adaptations in different plants needed to assure an ecosystem's ability to capture solar energy and convert it to chemical energy throughout a full range of growing season and climatic condi-

[2] Although the author's own, this definition contains many of the essential components of ecosystem integrity identified by others (ref. De Leo, G. A., and S. Levin. 1997; The multifaceted aspects of ecosystem integrity).

tions. The importance of this cannot be overemphasized; it is key to an ecosystem's baseline productivity. After all, it is the sun that fuels almost all life on the planet.

Diversity and abundance of plant species is important to making the system efficient in other areas too, such as capturing and holding available moisture on the landscape, or supporting a species-rich and abundant supply of soil micro-organisms essential to the plant's uptake and transfer of nutrients found in the soil.

Depletion in photosynthesis due to loss of plant diversity is one of the most important factors needing to be addressed through ecosystem management on many public land ecosystems. This has been a long-standing problem for which a variety of solutions have been sought, mostly with limited success. Ecosystem management (or stewardship), as will be presented throughout the rest of this chapter, potentially offers solutions that may otherwise be unattainable.

Ecosystems have evolved not to be static, but to change their species composition in response to natural disturbances, including floods, fire, pests, drought, etc. Many ecosystems have a natural range of variability through which their species composition ebbs and flows following major disturbances, such as fire. It is this ability to adapt to change that is so important to the persistence of ecosystems and species over time. Some species (both plant and animal) actually depend on various natural disturbances for their survival. Having a full complement of species represented is essential to this capacity for resiliency, as is a wide complement of genetic variability for each species present.

Fire is now being reintroduced into many western ecosystems after many decades of trying to control it. For many of them, it is now understood that fire is essential to the maintenance of an overall form and structure needed for the system to function properly, including the provision of habitat for species normally associated with them. On the other hand, due to non-native invasive plants invading other ecosystems, fire has become a very serious problem, particularly in desert ecosystems where fire was probably never a factor in their natural states.

Other natural disturbances are being introduced to affect ecosystem recovery and function, such as inducing flooding along rivers and streams where, otherwise, dams and reservoirs unnaturally control flows.

Finally, ecosystem connectivity is an important consideration. A wide variety of human activities since settlement of the West have served to fragment recently connected landscapes and ecosystems (e.g. human settlements of all forms, development of related infrastructure, clear cutting of forests, agriculture, and various other land uses). But the issue goes well beyond just physical features on the land; attitudes, knowledge, and values all serve to fragment the land, too. All one has to do is to fly over the country to see the impact of different grazing intensities on the land, for example. Sharp changes in plant density along fence lines are readily discernable even from high altitude.

In ecological terms, landscape fragmentation due to modern human activities is quite recent, at its oldest perhaps less than 200 years. The ultimate effects of landscape fragmentation upon individual species and whole communities of plants and animals have probably yet to unfold, but ecologists have long known that ecosystem connectivity is essential to species persistence, richness, diversity, and abundance.

A British botanist, H.G. Watson, first established that principle in 1835. Although details of the concept have since been enlarged, the relationships between land area, biological diversity, and ecosystem health and function remains a fundamental tenet to landscape ecology.

Although this discussion on ecosystem restoration is quite simplified, it should be sufficient to illustrate that ecosystems are interconnected and multi-dimensional. Their natural complexity, taken together with the many complex questions on the human side of the equation, should make it clear that solutions will not likely be found though government acting alone, nor by agencies and people acting independently on portions of the fragmented landscapes we have created. A more common understanding and purpose must be shared among us.

Many social and economic considerations loom large against finding solutions to this conflict between humans and nature, but productive harmony nonetheless demands that those solutions be found. The social and economic value of ecosystems must be factored in, but that narrative is highly unlikely to develop at the national level, in part because of the divisive nature of politics these days. Such a narrative might be possible locally, however, where the connections between people and the land are much more evident, and where the exact nature and value of ecosystem integrity can be more closely examined and communicated.

Managing Ecosystems through Local Culture: Probably no event in recent history better illustrates the fact that we still have human cultures and economies deeply rooted in natural ecosystems than the oil spill in the Gulf of Mexico. Fishermen, shrimpers, and beachfront resorts and others have all been serious impacted; it is only the degree and longevity of those impacts that remain uncertain. People's cultural heritage, their attachment to the ecosystems they depended on, may be even more affected than their economies. At one meeting held by the oil company responsible for the spill, a company spokesman promised to make everyone whole again. A fisherman stood and asked with deep emotion in his voice; "How are you going to restore my family's heritage and a way of life that goes back for generations?" The company man had no answer. One wonders if such questions were asked at all when the environmental documentation was prepared for these deep water drilling operations.

We have barely entered the twenty-first Century, yet we may be seeing more damage to ecosystem based economies than ever before. In addition to the example above, the crabbing and fishing cultures of the Chesapeake Bay area have suffered due to excess fertilizer running off watersheds draining into that bay. Much of that runoff has been attributed to industrial scale chicken and pig farming, although there are certainly other factors, too.

On certain public lands of the West, where only a few years ago landscapes were comparatively pristine, there are now industrial zones of oil and gas production, with air and ground water problems normally associated with just that – industrial zones. Here again, there are questions concerning the adequacy of the environmental impact studies, particularly as they relate to the fracking[3] chemicals used to open

[3] Fracking is the process of pumping millions of gallons of water or chemicals into the ground to help extract natural gas. The pressure causes the ground to fracture, releasing natural gases.

up the area's gas bearing geologic formations. Communities located near some of those areas have been completely transformed, and many citizens who were there before are seeking to relocate. Literally, some of the water that comes from taps can be lit on fire. Some ranchers have been displaced, while others nearby are wondering if they are next.

As a nation, our desperate rush to support the ever growing, mostly urban, and highly consumptive economy seems to be ignoring the more rural, land-based economies (except, perhaps for corporate farming). Much the same is happening around the world. For the first time in human history, more people now live in cities than in rural areas.

John Wesley Powell, geologist and explorer of the American West, recommended that the land there did not lend itself to settlement according to the rectangular survey system used in the East. Although his advice went largely unheeded, the reality of settlement occurred pretty much as he predicted. Today, the underlying land-based cultures of the West seldom conform to the artificial boundaries we have created. Instead, they closely conform to the land forms and natural systems recognized by people as they settled. After all, they made their livings by farming, logging, or ranching. The land itself defined those enterprises, and ultimately helped to shape the cultures associated with them. Although urban growth has served to displace or hide some of those cultures, many remain largely intact.

Although the history of these land-based cultures is utilitarian in nature, the question must still be asked: Could they become the bedrock for ecosystem management in the future? After all, these are people with deep roots and connection to the land. If their cultures could assimilate and employ the knowledge needed to restore and support ecosystem integrity, a much-needed human connection to the land would be preserved in an otherwise urbanized society. If ecosystem management cannot be practiced in the cultures associated with land and water ecosystems, then where can it be?

For many years, public land ecosystems were used in ways that often impoverished their natural productivity and resiliency. Livestock grazing, for example, when done with a view toward natural land as simple pasturage, tends to reduce those plants most susceptible to grazing, thereby affecting full photosynthetic productivity, along with accompanying soil loss and overall drying of the landscape. Managing forests with a singular focus on timber production, when taken to its absolute potential, results in treating forests essentially as agricultural areas, complete with herbicides, fertilizers, and genetically selected restocking materials. Similarly, many wildlife and fisheries management practices have had detrimental impacts to overall ecosystem productivity and diversity.

Most narrowly focused natural resource management practices have either been discontinued or altered in the last few decades, but changing cultural and institutional thinking to that needed for ecosystem management is a much bigger challenge. Land based cultures, as well as many natural resource institutions, must adopt knowledge essential to restoring ecosystem integrity as important to their own endeavors and purposes, not someone else's. Pressure to change might come from outside, but it is the culture itself that must decide to adopt change. The good news is, once they are anchored in culture, the ethics, knowledge, and practice of ecosystem management are more likely to be passed along and practiced without continued outside pressure.

A friend was cutting his winter's supply of firewood from the National Forest in northern Arizona a few years ago. Having cut the wood, he backed his pickup off the nearby dirt road and began loading it. Shortly, a rancher came by. He stopped, got out, walked up to my friend and said; "Hello, just wanted to say that around here we don't think we should be driving on the land." My friend, himself a public land manager, was taken back. Embarrassed, he apologized and explained that he was glad to hear there was someone other than the government looking out for the land. A pleasant conversation ensued.

Supporting Local Stewardship: There is another phrase contained in Section 101 of NEPA important to these discussions: *The Congress recognizes that each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation of the environment.* The underscored language is about stewardship, not only stewardship by and through government, but stewardship as a condition for responsible citizenry.

When it comes to the public lands and their resources, society's view of stewardship is conflicted. In fact, the term "stewardship" is not used much at all these days, at least not like it was a few decades ago, when it commonly applied to farming and ranching practices. Today the dialogue has become mostly single issue focused. We have arrived at a time where many people condemn public land health when they see cattle on it, but praise it if they see wildlife or wild horses. Never mind that the land supporting the cattle may be well managed and in excellent ecological health, while the land supporting the abundant wildlife or horses may be terribly impacted by their excess numbers. Today, bias often prevails over facts, and facts are often challenged as biased.

Lack of trust and distance from the land are big enemies of stewardship. They tend to push power upwards in the system and demand more from government, not less. Somehow, more effective linkages between local people and others concerned about public land health – people who can literally be scattered from coast to coast – need to be secured. The current system is not succeeding in doing that. Rather, it seems only capable of exacerbating the problem.

One thing that is needed is a more singular source for information and science to serve local stewardship, but capable of gaining the trust of people elsewhere. As it is now, that source is worse than lacking; information is widely dispersed and often competitive.

To provide a more reliable source for information to serve ecosystem stewardship, teams of ecological expertise might be organized by ecoregions,[4] without regard for the boundaries serving different agencies or their territories. These teams would have to gain credibility with local people and institutions since that is where where ecosystem management is practiced. To succeed, these teams would also

[4] Ecoregions cover relatively larger areas of land that supports geographically and ecologically distinct assemblages of animal and plant communities.

have to gain the confidence of people elsewhere who are concerned about public land health. Linking both local and more distant interests with a reliable source of science and expertise might be the single most important factor in making locally based ecosystem stewardship possible. Stewardship must be empowered with reliable information specific to the area in which it occurs, but broadly trusted.

It may seem odd to the reader, but another critical step might be to redefine stewardship, perhaps as follows:

> *Ecological Stewardship* – The practice of carefully managing land uses to assure that the essential needs of ecosystems and other natural systems are met with as little human input as possible, thus allowing them to restore and maintain their natural ability to indefinitely sustain themselves, while providing goods and services to present and future generations.

This definition is inclusive of both the human and natural economies. Unlike the past, however, it calls for adjusting human uses of the land to conform to the needs of the ecosystems, rather than the other way around. It would not preclude managing ecosystems to make them more suited to human needs and desires, only that it is done within the ecosystem's natural range of variability. In effect, the definition would flip the long-standing relationship between modern humans and nature. This potentially has enormous political implications, but if adopted at the community level, this change might do much for engendering trust with the larger society.

The definition denotes that ecosystem stewardship often requires little in the way of additional human inputs.[5] If the native species components are in place, ecosystems will usually respond very favorably, even dramatically, to well considered changes in how we manage them. For too long we have used human inputs to modify ecosystems in ways we thought fit the uses we wanted to make of them. In effect, what is needed now is a form of stewardship that has been largely lacking throughout most of public land history, one that doesn't try to dominate the land, but coexist with it. It is that form of stewardship that can gain respect and support by the larger society, and eventually help to move more power downward to the local land steward.

During the author's career in natural resource management, he knew only a handful of ranchers who essentially saw the land through the eyes of an ecologist. The land these ranchers used was in a much higher state of ecological health than the area's norm, including areas managed under the strict prescriptions of government imposed grazing management plans. Extending that kind of local knowledge and practice to landscape scales, with it eventually becoming part of the local culture, should be seen as one of the central challenges of ecosystem management. This challenge will never be met, however, without moving much of the power now held in the hierarchy of government down to people. In the author's opinion, developing a highly informed stewardship presence on the land, comprised not only of government, but also of users and other interests of the public lands, should be one of the highest priorities for the future of public land management.

[5] There are ecosystems so dominated by exotic, invasive plant species, or compromised in other ways, that it is doubtful they could ever restore themselves without additional human inputs.

5 Part 4: Community-Based Ecological Stewardship (CBES), a Concept

Given today's political environment, it is impossible to imagine that the types of environmental legislation passed in the 1960s and 1970s would now be possible. Back then, our nation's lawmakers, and then President Richard Nixon, agreed to the goal of productive harmony as defined by the National Environmental Policy Act, sometimes called our nation's environmental Magna Carta. Over the past 30 years, however, we seem to have slipped further away from that goal, while watching the political process become more ideologically divided and the environmental sciences being placed largely off limits to the nation's political discourse.

As already discussed, the challenges posed by productive harmony are many and multi-dimensional. Even if government were acting with more common purpose today that alone would not be able to solve the many interrelated social, economic, and environmental challenges faced. Somehow, the vertical systems of government and horizontal systems of society must come together with a synergy that has, to date, not really been possible.

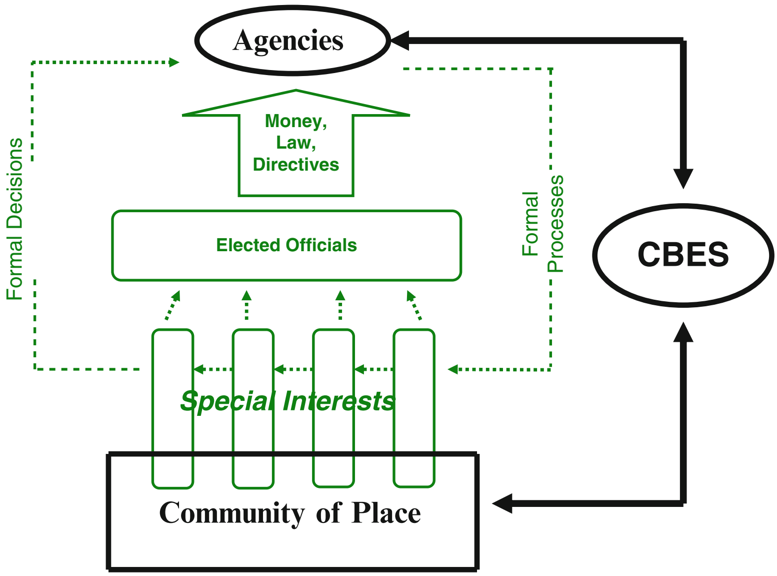
The concept of Community-based Ecological Stewardship (CBES), as will be discussed here, is a model not only for government and citizenry to interact toward a more common and productive purpose, but also for science to engage in ways that help to inform and attain that purpose. The public lands of the West offer a unique opportunity to put this idea to the test.

Basically, CBES is about empowering place-based social networks and other interests inclusively with useful and reliable information, helping them to process it, and allowing them to either adopt or reject it as a matter of choice. The hoped for outcome is that widely respected science and information becomes part of the local wisdom, and thus a part of the local stewardship ethic. Greater freedom to apply those ethics to the uses made of the area's public lands would then be provided, and enlarged over time. The integration of social and economic considerations would be part of the process.

CBES is about fundamentally changing the role and function of government to achieve a different end: A more informed and empowered citizenry sharing a more common future. It requires that the laws and policies pertaining to the public lands be adhered to less through dictate than by consensus building, but adhered to nonetheless. CBES is about citizen responsibility for public land use, not government control. A greater sense of individual freedom and choice, guided by common knowledge and purpose, is the desired outcome. The process should help build a more open, civic dialogue through the principles of good governance (e.g., inclusiveness, openness, legal compliance, effective action, accountability).

The author defines *Community-based Ecological Stewardship* as: *A citizen centered process through which people, government and science interact to share knowledge, build consensus, and gain mutual understanding, ownership, and responsibility for attaining a productive and sustainable relationship with the land.*

What CBES should NOT be thought of is another form of public involvement in government decision-making. The process, in fact, must essentially be conducted outside of the formal systems and processes discussed in Part 1, as illustrated below:



5.1 *Model 3*

Perhaps a better way to look at it would be to say that, although the CBES process happens largely outside of the existing formal systems of government, it still must be connected to and supported by those systems. CBES must also be connected to and supported by the social and cultural networks of place. Since the process aims to bring together the powers of government and community in support of local empowerment, creativity, and problem solving, both governmental and social constraints must yield to that purpose, if it is to succeed.

Guiding Principles: Both participants and observers should come to view CBES as a process of good governance. To garner local support and participation, the process must be seen as truly empowering and not overly constrained by government. For it to gain support by wider interests to public land management, the process must encourage diverse participation, conform to law, and involve widely respected science and information. The following principles should apply regardless of location or circumstances. They are intended to help people succeed in CBES.

1. **Transformational Leadership:** Transformational leaders are respected individuals, with or without formal authority, located in agencies and communities

who are willing to take risks to affect change. Their authority to act comes from within; they believe that this is the right thing to do. They tend to have a strong vision for a better future and believe in the ability of people to work together. They lead from behind by working through informal networks, and they use consensus-building techniques to achieve results. Transformational leaders naturally extend and share leadership with others, listen carefully, willingly share their own resources and information, give credit to others rather than themselves, and work diligently toward broad understanding and agreement. It is important that agency officials recognize transformational leaders in their own organizations and enable them to work effectively on behalf of CBES. It is also important to recognize and support transformational leadership from within communities, other agencies, various institutions, etc.

2. **Citizen Empowerment:** With the understanding that there are provisions of law, policy, and applicable science to public land management and administration, there remains a wide range of options to improve their management, many of which cannot be attained by agencies acting alone. For CBES to truly succeed, the process needs to creatively explore any and all such opportunities, and implement those that look promising. Constraints to empowerment are not limited to government; social and cultural networks of place can place severe restraints against their member's participating in such a process. There are plenty of examples where a local public land user is no longer welcome at the coffee table, once they are seen as a cooperator. Vigilance against all limitations to empowerment must be a part of the process.
3. **Inclusiveness:** CBES must provide for a wide range of information and values to be openly exchanged, discussed, and understood. The process must be deeply democratic, with empowerment extending to all people from within the community of place, and to others who wish to contribute.
4. **Consensus building:** The dialogue and its conclusions must result in shared ownership and responsibility. A vision or plan that is supported by both community of place and the larger society is one that can be successfully implemented.
5. **Applied Science and Information:** Agencies and institutions must commit to serving CBES with widely respected science, information, and expertise. Science must foster and support mutual discovery and learning. Scientists involved in the process must gain and hold the trust of the people and respect local knowledge and expertise. New sources for science (e.g. landscape ecology) will be essential.
6. **Adaptive Management:** Monitoring, information processing, and continuous learning are shared responsibilities. What is learned is incorporated into the common knowledge through consensus, not dictate.
7. **Cultural Adoption:** A desired outcome is for local culture to apply and carry forth the knowledge and practices needed for productive harmony and ecological stewardship. Each culture will be different and deserves to be understood on its own terms. In some cases, it might be necessary for the affiliated church to first become convinced that there is a need for change. In others, there may be

a lost history of past use that, if restored, could help to form cultural background for stewardship. Applicable law, science, and best management practices must all be considered.

8. **Collaboration:** Collaboration should lead to new and lasting relationships for identifying and serving the common interest. When mature, collaboration should have many of the following characteristics:

   - Individuals and organizations committed to shared objectives.
   - Institutional and organizational aligned with common goals.
   - Dispersed and shared leadership.
   - Shared risk taking and accountability.
   - Pooled, shared, and leveraged resources.
   - New people, information, and ideas are accommodated.

9. **Capacity Building:** Capacity can be judged by how well credible, useful, and constructive information is processed and adopted through the social networks of place, and how well the feedback loops work to support the process of mutual learning. Building and maintaining capacity requires:

   - Honoring commitments to people.
   - Bridging ideological, organizational, and cultural boundaries.
   - Sharing information and resources.
   - Acting in wholly trustworthy and accountable ways.

10. **Transparency:** For CBES to gain the trust of the larger society it must operate with complete openness. Whatever comes from the process, from vision to implementation, should be made readily available for all to see. Websites can help to serve this purpose.

Trends: For more than two decades something different has been happening in the West, and presumably other parts of the country too. Citizens of communities are coming together to better define their common future and work together to attain it. In the West there is any variety of examples, large and small. Some are focusing on a single activity (such as grazing or off-highway vehicle use) while others are learning to adjust to the decline of their natural resource based economies. Still others are dealing with a wide range of interrelated issues and concerns affecting their communities and surrounding landscapes. The best and most successful of these generally have a wide range of interests involved.

Many of these efforts have a landscape focus, such as watersheds, grazing lands, forests, aesthetic surroundings, etc. In one example in southwest Colorado, there are several communities from very different cultural and economic backgrounds working together on a common watershed. Initially suspicious of each other, these diverse communities have learned to come together for purposes of their common interests. This is only one of many examples where once disparate groups are learning to trust each other. It is not unusual for interests that were formerly at odds to now be working together for common solutions.

The most successful of these efforts use basic principles of good governance. In the author's opinion, at least one failure can be attributed to the fact that a few people tried to control the outcome, rather than working to assure broad participation, with shared vision and responsibility.

Another important factor is that the more successful of these community-based efforts began as a citizen initiative, rather than by outside influences, such as public land agencies. It is not unusual that a single, highly motivated and committed individual brings citizens together to act. These people often have no special powers of office, nor other formal standing, but they may share certain other leadership traits that will be discussed later.

The author once attended a community visioning session in which a rancher was the first to speak up and say; "I don't think anyone in this valley cares about those endangered fish in the river." A lone voice in the back of the room spoke up; "I do." A brief and somewhat testy exchange followed, but the rancher had to concede that he was wrong. Then the other man explained that he was a schoolteacher, and that one of his main concerns was that the cost of living in this community on a teacher's salary was becoming difficult. An excellent dialogue between the rancher and the teacher followed, the rancher saying that if he could only make enough money he would be willing to hire teachers in the off season. Then others chimed in. The exchange of ideas soon led to the beginnings of a much broader statement for the community's future, including its surrounding landscapes, its cultural heritage, its economy, education system, and the overall health and vitality of the community itself.

As the dialogue continued, words and phrases were added to the statement, then challenged and discussed further. Someone would suggest alternative wording and a whole new discussion would begin. Before long a statement that everyone generally agreed to was beginning to take form. Much work remained to be done after that initial effort, but it was clear that something important had happened, voices that had not yet crossed paths in this community had come together and realized a more common purpose.

Basically, the challenge in CBES is to extend this kind of momentum to the public lands, and do so in a manner that is supportable by the larger society. There are many positive examples of agency involvement and support for these citizen/community-led efforts. It has not been unusual for local agency officials and staff to work outside their normal duties and schedules, as defined by the formal systems, to do so.

Are these citizen-led efforts moving in a direction that could be called ecological stewardship? In the author's opinion, many are. However, that conclusion does call for further explanation.

Many people argue that until actual improvement on the land is made, with evidence of ecosystem improvement, these examples of collaboration cannot be called successful for purposes of ecological stewardship. However, if viewed through a different lens, one that says ecological stewardship is not only about the land, but social and institutional change too, then one might reach a different conclusion. Many of these examples have already changed the dynamics among people and institutions in ways that, in the author's opinion, are making fundamental progress toward ecological stewardship. Besides, there are examples of successes on the land too, from improved rangeland and forest to, in at least in one case, citizens successfully holding off a large scale development that would have damaged their watershed and permanently changed the character of their community.

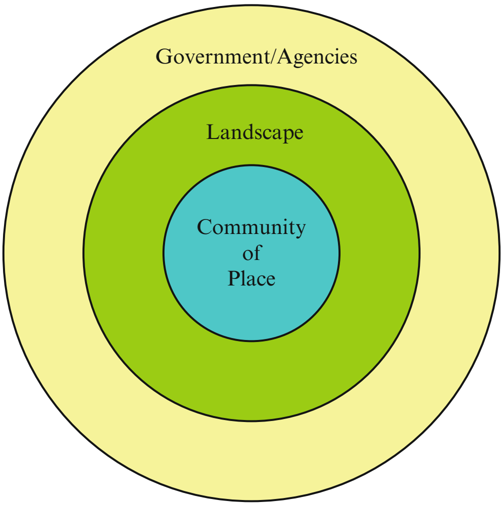
Overall, most of what is happening through these efforts must be considered positive toward the purposes of CBES. The effects are mostly local, but the beginnings of a broader movement toward ecological stewardship might just be in the making. What is happening is spontaneous and organic; it seems to have power of purpose that will not be denied. They are motivated by a sense of community and citizen responsibility, just as envisioned by NEPA.

It is the author's understanding that, according to the experts on such matters, other trends in the U.S. and elsewhere in the world suggest that power is moving away from centralized sources and down to people. If that is true, shouldn't it be government's responsibility to examine their programs, operations, and assumptions and begin to make appropriate and needed adjustments? It would seem that battling over old ideologies would be the least of things they should be concerned about.

6 Part 5: Transforming to Productive Harmony and Ecological Stewardship

The system now operating on the public lands, being largely issue driven and subject to changing ideologies, is ill suited to the pursuit of productive harmony. It is proactive to business and economic interests but mostly reactive to social and environmental concerns. Fundamental changes are needed to realize the outcomes defined in NEPA some 40 years ago.

The following illustration suggests a more environmentally proactive, place-based model for public land management, the context being one of people caring for each other and the surrounding landscapes through shared vision and purpose, compatible with national standards and objectives.



6.1 Model 4 – Place-Based Ecological Stewardship

The model implies that a new relationship between communities of place and natural resource agencies is needed to support landscape stewardship. That relationship, and the conditions needed to achieve it, are discussed below.

Community of Place: Some call the migration to the West that started some 30 years ago the greatest demographic change since settlement. Any community nestled in the grand landscapes of the West has attracted many newcomers, bringing different values and expectations, along with their own hopes and dreams. Restaurants offering new cuisines, and other businesses more characteristic of distant large cities, can now to be found in many small western towns. Business people from other countries too have settled there, especially in locations that promise even more growth in the near future.

But other communities are still very much as they were before all this change. Many still have natural resource based economies and largely the same attitudes and values as before, in spite of the growth and change elsewhere. There are entire states where politics have changed little over the last three decades, even though their populations and economic diversity have. There is little apparent uniformity in the West these days; diverse attitudes, ethnicities, economies and politics are the norm. The American West is a place trying to adjust to rapid and dramatic change. Nevertheless, that underlying culture of the land discussed earlier remains mostly intact. Large expanses are still the West of yesteryear.

Shifting political ideologies operating through the natural resource agencies have left their marks too, both on the land and its people. In the 1990s, for example, large areas of the West were designated as National Monuments without the approval of many of the locals, particularly those representing natural resource based cultures and economies. There remains anger and resentment over that even today. A decade later, similar top-down decision-making affected other lands and peoples, this time with industrial-scale oil and gas development to areas of the public lands. This too was done largely without the consent of locals. In places, it severely impacted the setting and character of some nearby communities. Resentment again was the result, but this time with an even greater range of people and interests who have since formed unified blocks of political and legal resistance.

Demographic change and certain acts of government over the last three decades may have helped create more fertile ground for CBES in the West. The rapid sweep of change has already helped to spawn a variety of community-based, citizen-led initiatives aimed at preparing for the future. A wide range of partnerships between federal agencies, users, and other public land interests has also formed, as they have between non-profit organizations and traditional users of the public lands.

There is little uniformity among agencies in how they approach these evolving citizen/community/agency relationships. Partnerships, ecosystem management, or watershed management are all terms variously used. A single concept common to all agencies, with common principles and understanding of how to proceed, has yet to evolve. CBES might be such a concept. If so, it must be carefully applied and developed. Otherwise, it might only add to the mix rather than helping to transform it all into a new and more consistent model for future public land management.

A primary consideration for implementing CBES is whether the community provides a climate suited to inclusiveness, transparency, and objectivity. Many do not. They remain so closed in their thinking that even people living there fear that their businesses or social and professional standing would be at risk if they spoke in favor of a locally unpopular position. That can be true of the community as a whole, as well as for their social networks. Individuals are sometimes ostracized because they simply opt to work with an agency. People of differing views and values, whether they are residents or not, must feel free to engage, and encouraged to do so.

There are examples where less socially inclusive communities have sought to define local public land management in ways that serve their own interests. Because those kinds of efforts generally do not adhere to the guiding principles previously discussed, most fail. There is a big difference between local control and shared responsibility. Even though land managers might see the problem developing in advance, stopping or denying it may be politically impossible. All of the tenets and principles of CBES discussed in this chapter must be carefully applied and adhered to without exception.

On the other hand, it is not sufficient to have a few people representing different interests in the community convene periodically to discuss and agree on matters germane to ecological stewardship or productive harmony. CBES is not a committee process. For there to be an outcome of sufficient scale and commitment to effect landscape stewardship, the various social networks of place must be effectively engaged, particularly those representing the area's land based cultures and economies.

Typically, government agencies are not very effective at widely engaging people through the social and cultural networks of place. They may be good at holding public meetings, but that is entirely a different process, serving different purposes. Citizen transformational leaders are normally better at communicating through place-based social networks. They tend to have the social standing needed to help build trust, and they are more likely to be accepted in different gathering places. They often can motivate people's involvement, whether it is a single social/business network (like ranchers), or more inclusive groups, like business people, teachers, and others in the community. The broader the participation the better, of course, but single interests should not be discounted as a source for collaborative stewardship. The more meaningful test is whether there is the positive and constructive energy needed for CBES to develop and succeed.

There are very good reasons to have CBES focus on managing whole landscapes. Doing so shifts attention from managing subunits of the landscape, such as individual grazing allotments, to the overall function and health of a more complete natural system. Individuals can perhaps for the first time see how they affect the larger whole, without being singled out, as they may have been in the past. Thinking in terms of landscape provides opportunity for different sciences, such as landscape ecology, to engage with people. That can help to refresh and change the old narratives, as well as help stimulate people's interest in new information. Finally, and very importantly, a focus on landscape can open for consideration other approaches for managing the land that might not otherwise have been evident.

Landscapes can help to change the dynamic to one of shared responsibility, including among agencies. A landscape focus is a decided change from what has been done throughout the history of public land management. Many people living in communities would very much appreciate a more common approach among agencies. If more than public lands are involved, however, the community must agree in advance. Otherwise, private rights will almost certainly become an issue. A good way to start the process is to first form a citizen vision for the community and its surrounding landscapes through wide and deep participation among citizens and agencies, and any other interests wanting to be involved.

Science: Currently, available science, information and expertise are widely scattered between agencies and among disciplines, programs, universities, consultants, and other sources. To make matters worse, there are differing and often competing schools of thought between the natural resource sciences and the biological sciences, the former being governed by the idea of sustained yield,[6] the latter obligated to the study of nature's design. There is hardly a system for science and information in place at all, let alone one capable of providing people and agencies a foundation for ecological stewardship and productive harmony.

A single source of reliable science has never been established for the public lands. Disaggregation of science and information is so complete that people can pick and choose from a wide range of available expertise and opinion to support their argument, or position. This problem needs to be corrected if ecological stewardship is to be possible. A well-founded and widely respected base of science needs to be at the table, again, not to decide matters, but to provide grounding, relevancy, and objectivity concerning ecosystem integrity, an essential component to productive harmony. Information concerning social and economic considerations is needed too, but without a foundation of ecosystem sciences, neither local people nor other interests in the public lands have a common base for understanding.

As discussed earlier, ecosystem integrity implies an "ecological imperative," or a minimal and inviolate condition that must be met for ecosystems to sustain themselves. Considerations for integrity potentially go right down to the microbiology present in soil, which is integral to the plant species expressed on the surface, and essential to nutrient transfer, cycling, and storage. Ecosystem integrity should also consider which native plants are needed to ensure optimal energy capture and productivity, and resiliency following natural disturbance. Other species (both plants and animals) may need to be considered from different perspectives, including habitat needs, connectivity of populations, genetic variability, etc.

[6] The harvest of a biological resource (e.g., forage, timber, fish) under management prescriptions designed to ensure regeneration before another harvest occurs.

Obviously, a wide variety of expertise and information could be needed for understanding and communicating ecosystem integrity. The primary emphasis, however, should probably be on a relatively new science called landscape ecology. It could be organized on an interagency basis by eco-regions, as previously mentioned, to better ensure that it becomes respected as locally relevant.

The social considerations for reconnecting science to people are perhaps of even greater importance. All information must be gathered and administered for the purpose of empowering people with what they need to know to succeed. Great care should be taken to avoid science being seen as a threat. If people see the government organizing science without them being properly involved, rumors might easily spread that make connecting science to people and community more difficult.

It will be important to get citizens involved as early as possible. The proposed eco-regional science teams could, for example, hold community meetings to determine what issues are important to local people. Bringing local knowledge into consideration as soon as possible might go a long way to help establish a base of common understanding and trust. The more inclusive these meetings, in terms of the public interests represented, the better.

At least two questions should be anticipated: What does ecosystem integrity mean for me? Why should I care? Science teams must be prepared to discuss those questions in both ethical and practical terms. There are many people who question that ecosystem integrity is important at all, and who might even consider it an obstacle to "human progress." Public narratives concerning this matter need to become less politicized. Bringing them down to the local level and tying them to real situations will help to do that.

CBES is based on the belief that most people want to do the right thing, but that the real challenge is finding agreement on exactly what that means, particularly when it comes to matters of ecosystem integrity. Science must empower people with information to help them reach consensus on "the right thing to do." Representative scientists need to be regularly involved in the process, but always in a constructive manner. Local trust is extremely important to that end. An already well-established individual (or individuals) from a local agency office might be the best choice for that role. These people could consult with members of the eco-regional teams, as necessary.

Because there have been so many issues surrounding the public lands for so many years, their management has become very legalistic and prescriptive. Virtually every action must be undertaken in preparation for a possible legal challenge. There is little opportunity for extrapolation from one location to the next, even though they may be essentially identical. New studies and data often must be produced specific for any one action. Because there is such little trust built into the system, even data and knowledge are not widely shared, not even within the same agency.

Adaptive Management is the process of improving resource management through continual monitoring, analysis and adjustment, but it must be practiced in a more constructive and trusting environment than currently exists for much of the public lands. Ideally, the responsibility for monitoring should be shared among users, agencies and other interests, and the results applied to other comparable situations without concern for legal challenges. Adaptive Management is about making choices, not legal decisions, using reliable information and consensus. Like CBES, Adaptive Management can help create and support the idea of a learning community, for all involved.

There is a one big precaution, however. It makes no sense to start with poorly founded assumptions, then spend what might be years to find out that they were flawed from the outset. A firm base of science and information is needed to help avoid making such expensive, time consuming, and nonproductive journeys. Science must be governed by standards and protocols that should not be violated merely for the sake of local consensus.

A national rule making process could establish these standards and protocols and also set minimal standards for ecosystem sustainability. Such rulemaking might help bring needed agreement among many scientists from the beginning. Dueling scientists have long plagued consensus-building efforts in public land management. To the extent they can at least agree to principles used to guide data and decisions on ecosystem integrity, the more effective science should be in helping support consensus building later on.

The importance of a solid foundation of science to the CBES process and its orientation to serving people simply cannot be overemphasized. Among all the considerations to be made relative to the implementation of CBES, in the author's opinion, science is the most important. Yet, it remains the most easily overlooked, and perhaps the most contentious. CBES requires fact-based discussions. Although that seems no longer relevant to the national political dialogue, it is essential to local civic discourse concerning ecosystem stewardship and productive harmony.

Government: The many years spent dividing up the public lands with different agencies, programs, and land classifications further complicate the implementation of CBES. It now is a system laden with challenges to interagency cooperation and collaboration. Even between very similar agencies, like the U.S. Forest Service (USFS) and Bureau of Land Management (BLM), the differences in regulations, policies, science, and procedure pose very real barriers. Other factors, such as the timing of land use planning, vary among agencies, even though they may be mere parts of the very same ecosystem, and involve the same community of place. Engaging people on a landscape or ecosystem basis is therefore made much more difficult. Public land management remains highly programmatic, issue based, and agency specific. Other than required by law, we have paid little attention to our relationship to natural systems in public land management. Nor have we considered the cultural systems that lay across the land.

In part it was in response to the concept of ecosystem management, but it also was the need for greater efficiencies that, beginning in the late 1980s and continuing through the 1990s, things began to change for the better. Across the West, once disparate agencies began coming together in ways unheard of not long before. The BLM and the USFS began sharing offices and resources in several locations in Colorado. Some are even sharing a field manager. In a variety of ways, once strong differences between agencies have been giving way to a sense of common purpose.

The National Park Service (NPS), Fish and Wildlife Service (FWS), USFS, and BLM, for example, are working together on the shared concept of the Greater Yellowstone ecosystem. (Note - Although clearly ecosystem related, this initiative should not be confused with the concepts for ecosystem management discussed in this chapter.)

In the 1990s a full complement of federal and state agencies came together to coordinate the management the Columbia River basin. That effort largely failed, in the author's opinion, because they did not collectively have a concept in mind on how to carry the science and information generated down to the communities and people closest to the land. Yes, it was another demonstration of agencies coming together around a shared purpose, but it also demonstrated their shortcomings in attaining that purpose.

What is largely lacking is the idea that successfully restoring ecosystem integrity depends as much on people and communities, as it does on government. It requires some form of letting go, an idea that is threatening to agencies and their public supporters alike.

In his book, "Sand County Almanac," Aldo Leopold argued that a land ethic that includes all living things, as well as the soil and water, must become a part of the same social conscience that serves to bond the human community together. He wrote; "*The land ethic simply enlarges the boundaries of the community to include the soils, waters, plants, and animals, or collectively: the land. The problem we face is the extension of the social conscience to the land.*" It is understood by students of Leopold's writing that what he was referring to was ecosystems (i.e., land) to which the human community should consider itself a part. He also argued that government was being set up to make the responsibility for conservation too easy, or even trivial, writing; "*There is a clear tendency in American conservation to relegate to government all necessary jobs that private [parties] will not perform; whatever ails the land, the government will fix it.*"

So, where have we come in those 60 years since Aldo Leopold wrote down these thoughts? Roughly half of those years were largely dedicated to doing exactly what Leopold was most concerned about, government investing in changing the land [ecosystems] to benefit the industries associated with them. Perhaps another 15 years were spent (there is some overlap) with people who were concerned for those ecosystems legally challenging what government and industry were doing. Their efforts, however, were made considerably more difficult in 1984 when the Supreme Court ruled that judges could not substitute their own views for a reasonable choice made by an administrative agency. Since then, the public lands have experienced ideological flip-flops from one administration to the next – one favoring natural systems, the next industrial and economic use. That may be a bit simplistic, but it is essentially the dividing line for which political dominance over public land management has been fought. Little has changed from the beginning of it all.

There is no easy way to quickly transform public land management to be supportive of a community-based process for ecological stewardship and productive harmony, but people who are taking responsible steps in that direction for their own communities deserve that support. Although they may have it from their local agency office, support needs to go all the way to the Washington headquarters offices, and higher. Otherwise, the many uncertainties inherent to the system will almost certainly undermine their efforts. There are many things to consider, some obvious, others not.

For more than 20 years, there has been the dominant view held in Washington that government can and should be run like a business, meaning among other things, that the outputs of government should be tangible and measurably efficient. In the case of CBES, the first outcomes are likely to be somewhat intangible (developing trust, improving communication, engaging the social networks, interagency coordination, etc.). These conditions may take considerable time and effort to accomplish. Once in place, however, collaboration should produce considerable gains in both efficiency and results. The indicators of government's success, and the means for measuring them, need to be rethought, with deference to a more citizen and community centered approach to public land management.

Other considerations might be important too, such as coordinating formal processes (i.e., planning and environmental assessments) among different agencies, aligning priorities across administrative boundaries, sharing of personnel and resources, resolving policy and procedural inconsistencies, or other matters important to empowering and supporting CBES. For example, funds and spending authority are now appropriated on a program-by-program basis, which mostly expire at the end of the fiscal year. To give the community based approach it fullest opportunity to succeed, those kinds of budget constraints might need to be relieved.

Since this is a citizen-based process, with collaboration potentially developing at landscapes and ecosystem scales, solutions and management prescriptions might look very different than those traditionally used. Resolving concerns on the public lands may, for example, call for investments on private or state lands. A number of legal issues would be raised if federal money were involved in such investments, even though it might clearly benefit the neighboring public lands. Any number of similar complications may arise.

CBES should be approached as a learning process. A clearinghouse set up specifically to help resolve disruptive sticking points as they arise might be needed. CBES is no less than a new approach to governance on the public lands. Congress might even provide authority to work outside existing regulations (within reason) to give full opportunity for the process to prove itself.

CBES indeed calls for deep and fundamental change in government thinking. Is it worth the time and risk? Perhaps all we have to do is look at the state of citizen discontent with the status quo to find our answer.

7 Part 6: Making Space for CBES

As a review, the system now in place for public land management is designed to provide the public a voice in matters subject to formal decision-making by government officials. This system has been mostly honored by natural resource agencies for more than four decades, albeit not without a considerable amount of litigation and controversy. Decisions made become the agency's responsibility to implement, but political influences may affect their ability to do so. This system was designed under a different theory concerning the role of government than that demanded by CBES.

To the degree that processes similar to CBES have been attempted within the existing system, it has largely been at the discretion of local managers and agency personnel. Such efforts have often had to seek private grants to help support the process, and have donated their time outside normal duties to work with people on their own terms and schedules. All of this serves to illustrate that the current system is not designed for CBES, which demands very different dynamics between citizenry and government.

CBES can help people and agencies collaboratively resolve many issues affecting the public lands and their users, engaging them as ecosystem stewards rather than as simply users. It might be the only way to effect ecosystem management at landscape scales concerning such matters as connectivity, biological diversity, and baseline productivity. CBES can help local communities better cope with future economic changes and uncertainties, many of which might not even be addressed under the current public land system, which largely remains driven by issues coming down, rather than up. The idea of shared responsibility among citizens, businesses and government may be the only way to resolve many otherwise intractable problems. Only the civic dialogue of place and landscape can lead to productive harmony.

Although there are various efforts now underway that resemble CBES, initiated either by citizens or natural resource agencies, probably none of these have been able to put together all the conditions needed to create a fully viable, place-based process. The challenge, again, is to bring the vertical systems of government together with the horizontal social networks of place in a manner that builds trust, supports creative problem solving, and empowers collaborative stewardship. To some degree, administrative power must be released by the agency to the process for such results to happen.

The nine principles presented in Part 4 are designed to responsibly empower the CBES process and its participants. They serve to release administrative power by requiring more natural controls – inclusion, transparency, reliable science and information, etc. The role of the local public land manager becomes one of assuring that these principles are properly applied and adhered to, rather than being overly concerned about outcomes. The principles, when properly administered, create the space needed for CBES to form and develop locally. Above the local area, however, there are bigger challenges.

Generally speaking, one organizational level above the field office is where agencies become more bureaucratized and programmatically bound. These offices tend to play an oversight role to field offices. They are the keepers of fiscal, legal, and policy authority and integrity. At two organizational levels above the field, we typically come to the Headquarters offices in Washington D.C, where similar oversight is carried out, but often from more of a political perspective. Above that we enter the Departmental levels, where the ideological influences come to bear. Bringing these different levels of government together in a cohesive whole to support CBES is a challenge that, to the author's knowledge, has never been achieved.

The further removed from the field, the more controlling and bureaucratic the system becomes and the more difficult it is to support place-based collaborative processes. Bureaucratic controls have evolved for good reason; without them, the very principles of good governance would be easily compromised. Nevertheless, there needs to be some relief from those controls to allow the CBES process to unfold and properly function. The nine principles previously discussed are intended to assure good governance in the process, but trust and empowerment are also needed. Anything that comes down from above that suggests to the people involved in CBES that they are not trusted can be very damaging. The odds of that happening are extremely high with the system that is now in place.

An actual event might help illustrate the point. A collaborative process was formed perhaps 13 years ago in northern Colorado that had many of the attributes of CBES, even though it was more limited in scale, both in terms of landscape and community involvement. The process was largely aimed at resolving livestock grazing issues on the public lands and elk grazing issues on private lands. The state Division of Wildlife, BLM, Fish and Wildlife Service, and other agencies were involved, a bit top heavy with government perhaps, but that is another matter. After a few years, the process was proceeding very well. Great progress was being made concerning both major issues – elk damage and livestock grazing. But then a very well intended policy came out of the BLM office immediately above the field requiring that all hay fed on the public lands be certified as "weed free." That seemed to make sense; after all, infestation by exotic plants on the public lands was generating quite a concern among many different interests, including ranchers. But this particular area had long been known for producing some of the finest timothy hay available anywhere. The locals were rightfully proud of their hay crops, and some of that hay was being used to help distribute grazing to relatively unused portions of the public rangeland. To be challenged on the quality of their hay, well that was quite an insult. The issue spread through local social and cultural networks like wildfire. It soon threatened to bring down the collaborative process. It took weeks to quiet down. That is how sensitive the trust issue can be. Yet it all began with the most well intended and seemingly inconsequential of policies, issued from only one layer of government removed from the field.

The CBES concept, as presented here, is one that requires considerable freedom from the constraints of government. Paradoxically, it also requires that government support the process. As already discussed, reliable science and information is needed to help people understand issues and find solutions. Beyond that, there are many other areas to consider for supporting the process, from project work to assuring that trust and empowerment are not unnecessarily violated. As one rancher said as he considered the matter; "Yep, the cake needs to be turned over, doesn't it."

As discussed earlier, transformational leaders are essential to collaborative stewardship. So far, however, these leaders seem to only arise out of agency field offices, or from citizens in communities-of-place. Perhaps it is the local interface between government and citizenry that generates that need, but if the potential of CBES is to be more fully explored, transformational leaders must also emerge at the higher levels of government, the higher the better. The following recommendations are predicated on that happening. They are simply offered in the spirit of sharing ideas.

Start a New Narrative on Productive Harmony: Although there were widely held discussions among natural resource agencies some 20 years ago concerning ecosystem management, an even greater discussion of productive harmony may be needed to promote understanding of what is required at all levels of government and society to foster it. As with ecosystem management, discussions on productive harmony would necessarily involve public land management, but this time those discussions should largely be held in communities-of-place. The role of government and the connection of science to people should be key parts of the dialogue. Obviously, the discussions would also be held within and among the various institutions, agencies, and other interests associated with public land management, as before with ecosystem management.

Just for the sake of discussion, let us take the idea a bit further. For national purposes, productive harmony might be framed around larger issues, such as how to find more common ground between the major political parties concerning the role of government, how to solve the high cost of government without sacrificing results, or how to reshape government to meet the needs of the future. Citizen, corporate, and government responsibilities to productive harmony could be made a part of such discussions. Perhaps the matter could be taken up at a national major's conference, with the results shared upwards in an attempt to start a larger, national dialogue.

The concept of productive harmony should not be relegated to history; it is more important now than ever. The National Environmental Policy Act once set a standard for the world to follow. Achieving its goals and objectives need not be legalistic, but rather collaborative and synergistic.

Establish ecosystem science as a core competency: Within and among agencies of the DOI and DOA, organize to provide requisite ecosystem specific science, expertise, and information, with landscape ecology as a focus. As mentioned earlier, this should be done for each recognized eco-region represented on the public lands; it is critical that this be done in a manner that clearly demonstrates the intent to have science serve people in ecosystem stewardship, not dictate to them.

Policy guidance: There is a need for policy guidance to better define the government's role and how to perform it, hopefully along the lines discussed in this chapter. For the public lands this should be done at an inter-agency level between the Departments of Interior and Agriculture (DOI and DOA). Other agencies might also be involved, either on their own, or perhaps together. These might include EPA and the National Oceanic and Atmospheric Administration (NOAA). The latter has the National Marine Fisheries Service (NMFS), which is believed to be pursuing similar concepts to manage oceanic fisheries through relevant fishing cultures.

Executive Order (EO): Although individual agencies have made efforts to move somewhat in the direction discussed in this paper (e.g.; ecosystem management), it is unclear that there has been any high level Departmental or White House policy specifically addressing it. There was an E.O.[7] issued in 2004 that vaguely got at the idea through what was called "cooperative conservation." In part, that E.O. read: *The purpose of this order is to ensure that the Departments of the Interior, Agriculture, Commerce, and Defense, and the Environmental Protection Agency implement laws relating to the environment and natural resources in a manner that promotes cooperative conservation, with an emphasis on appropriate inclusion of local participation in Federal decision making, in accordance with their respective agency missions, policies, and regulations.*

A new and much more specific EO announcing the intent of government to pursue community-based ecological stewardship, and setting forth the provisions for doing so, would establish the concept as policy and help to assure its effective implementation.

Provide needed legal and funding authorities: The normal appropriations process takes 2 years, beginning with the President's Budget Request and ending with the annual Congressional Appropriations Act, which becomes law once signed by the President. Although they do provide some flexibility to accommodate the uncertainties and variables in the normal course of a business year, these appropriations acts are generally quite specific for each agency and its programs. Congressional authority may be needed for greater budget flexibility to serve CBES, if only for the length of time required to evaluate results.

Authority to establish a clearinghouse might also be considered. Since CBES is a learning process, feedback loops to and from ongoing examples could help resolve unanticipated problems and take advantage of new opportunities. A clearinghouse, if provided the right resources and authorities, could do much to assure the space and support needed by CBES is provided, while avoiding the complexities that might otherwise be encountered.

Find and enlist good candidates for CBES: Various community-based collaborative processes already exist. Some of these would serve as trial areas to determine what potential the collaborative process might hold for public land management, and to better define the government's role in supporting the process. The following criteria for recruiting and selecting candidates might apply:

- Ideally, leadership for the stewardship effort arose out of community itself, rather than as a government-led initiative.
- A diverse representation of place-based citizen interests has formed, with most of the social and cultural networks of place represented.
- There is dispersed and shared leadership within the community, and others involved in the process.
- Other interests, such as NGO's, are included, or at least welcomed and encouraged to join.

[7] E.O. 13352.

- The process is supported by a source of widely respected science and information devoted to landscape ecosystem integrity.
- There is a common focus on the natural functionality of an entire landscape, rather than the artificial boundaries within it.
- Agencies and other institutions involved are devoted to empowering and supporting the process, not controlling it.

If candidates cannot meet all these requirements, could they do so?

Support: Agencies should be prepared to fully support CBES, not only by completing project work in a timely manner, but also by helping resolve unanticipated problems as they arise, and avoiding government actions that might do damage to the process (i.e., trust and empowerment). CBES must be supported as a bottom-up process for public land management, while assuring that applicable laws, policies, national objectives and the tenets of good governance are not damaged in doing so. Where appropriate, government officials should be able to meet with participants to the process to help clarify and fully discuss such matters.

8 Part 7: Opportunity and Choice

Some 35 years ago, a public land multiple-use agency began its journey into land use planning, but how it began that journey was very different than what evolved only a few years later. In the beginning, it described the planning area's economic profile, its communities and infrastructure, and to some extent even its cultural and social settings. The area's ecosystems (or plant communities) and their relative health were also evaluated. All of this information served as a context for the future management of the public lands administered by this particular agency. The final result was called a "Management Framework Plan," a fairly specific but still somewhat general plan for how the public lands would be managed, in consideration of the local situation as well as in the national interest. The plan was prescriptive, but not so specific as to overly encumber management options.

This approach to planning came under immediate scrutiny by any number of national interests concerned with public land management. After all, these were national public lands, not local, and they should be made subject to national standards. Before long the agency's planning process was transformed, with programs leading the way. It was only a matter of time until the debate shifted even further: Just how detailed should these plans be? Some argued that they should plan down to the very smallest detail, with future projects being shown to their exact locations. Others took a more practical view; while perhaps not framework plans, neither should they be so detailed as to limit the agency's options altogether. In the end a compromise was reached, but still the plans were far more specific than originally envisioned. The lack of trust had successfully pulled the agency away from its local affiliations and into the national hierarchy of oversight and control.

That lack of trust was not without reason. The users of the public lands administered by this particular agency had held a pretty firm grip on things for many years. To serve the national interest, that grip had to be broken. The public lands had to become recognized as belonging to the nation if the agency in charge was ever to be a viable public land manager. In the ensuing years and decades, that battle was fought time and time again. Yes, it resulted in the lands and the agency becoming seen as more national in stature, but ties to the local people could not be completely broken either.

This brief story of one agency and one class of public lands raises important questions concerning the idea of community-based ecological stewardship:

- Can the national interests in public land management be entrusted to local people, or to an agency with a history of strong ties there?
- Can ecological stewardship evolve out of a history of natural resource based economies and cultures?
- Can public land users practice ecological stewardship simply out of a sense of citizen responsibility, rather than control and proprietorship?

All of these are legitimate questions, and they will likely be key topics for discussion as the future unfolds relative to community-based ecological stewardship, or whatever name collaborative stewardship might go by. In the author's opinion, however, the answers to these questions will largely be determined by an even bigger consideration: Will ecosystem integrity itself become a national priority in the eyes of the larger society?

As a society, we do not think of the public lands as representative of the once grand and often unique ecosystems that spanned the West before settlement; but that they are. Nor do we consider them to be culturally and socially connected to the many people of the West; but they are that too. Instead, our views toward these lands are largely formed by the designations we've made of them, – national parks, refuges, multiple-use, etc. – and the uses we make of them – camping, hiking, off highway vehicles, bicycling, and the like. Others look at them as the place where the last wilderness can be found, or perhaps as a refuge for the majestic wild horse. Our views are very individualistic and mostly self-serving. To a large degree, we've designed the agencies and their programs to manage the public lands according to these fragmented societal values.

When examined in the broader context of ecology, with human values considered in addition to ecosystem integrity, much of the public lands system is in decline. Areas that only a few years ago were characteristic of the wide-open spaces of the West now resemble industrial zones, with water and air quality problems to match. In other areas, cities are growing with such force that they leapfrog out onto the surrounding landscapes. Broad expanses of human development tear at the very fabric of rare and valuable ecosystems. In many places, recent human development now mars and fragments landscapes that were largely intact only a few years ago. Ecosystems? Productive harmony? Stewardship?

In terms of ecosystem health a good portion of the public land system is already in critical condition, or worse. Climate change is having enormous impact on the West. Natural forces once held in check by climate, like insect infestations and fire, are now biologically altering or destroying entire landscapes. Desertification is happing in our lifetimes, but just how aware of that are we? Alien plant invasions are spreading like wild fire too, leaving in their wake ecosystems so altered that, for all practical purposes, they have been ecologically destroyed. Whole populations of birds are in decline, as are other plants and animals. The whitebark pine (*Pinus albicaulis*), so important to grizzly bear habitat in many parts of their remaining range, is now threatened with an infestation of rust introduced from Europe.

These landscapes were not in this condition when we first found them. To the contrary, they were ecologically diverse, whole, and verdant. Whether desert foothill or mountain valley, these lands had biological abundance that can only be imagined today. There are those who doubt this, but it is quite true. On their own, ecosystems naturally move toward diversity and abundance. The degradation of western ecosystems started less than two centuries ago. What remains of them on public land today will likely continue to degrade as long as we approach their management in such a fragmented and compartmentalized manner, fragmentation based on human values, not natural systems. More than that, their degradation will undoubtedly continue as long as we fail to see them for their inherent natural value and ecological importance.

Why change? Why focus on ecosystems as a foundation underlying the management of the public land system of the western United States? Are there reasons now to do so, when in the past we have chosen not to?

George Perkins Marsh published a remarkable book for its time in 1864, in which he argued that it the ancient Mediterranean civilizations collapsed due to environmental degradation. But he went on to acknowledge that we humans are not destined to sit idly by, that it is in our nature to explore, develop, and progress. For that very reason, he argued, we are responsible for the Earth. We are destined to disturb nature's harmonies, but we must learn to do so as good stewards – not vandals.

It can be argued that we have sought to do just that, be good stewards of the public lands. But the conflict between economic productivity versus nature has always been there, with each side having its own sense of what stewardship means. Aldo Leopold, after a long career in natural resource management practicing the utilitarian view, changed his thinking in later life. He wrote: "*A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise*." That may be a suitable description of ecological stewardship. It doesn't deny the human use, but only asks that it be undertaken with respect for the design and function of nature.

Have we as a society matured in our views of the human responsibility to ecosystems as Aldo Leopold did? Unfortunately not, self-interest still remains a strong driving force in much of our society. Politicians and commercial interests exploit that self-interest in a myriad ways to promote their ideas and products, each growing rich and powerful while doing so. That is not to say that there are none of us concerned for our environment; undoubtedly, the majority of us would say we are. But how many of us think of ecosystems when we say, "the environment?" Or, if we do, how many of us really understand what that means, or associate ourselves with an ecosystem? Perhaps the people who do think in those terms are those whose livelihoods are closely tied to ecosystems, the very people that others might view as the exploiters of ecosystems. We briefly heard from some of them during the recent oil spill in the Gulf of Mexico. All too soon their voices faded away.

Yes, it is at the local level where people have the greatest affinity to the ecosystems that surround them, and then mostly in the smaller, and to some degree, natural resource dependent communities. Isn't it interesting that these are the exact communities that often harbor the greatest resentment to outsiders telling them what to do, or toward government, who they see as representing those outside interests?

Many issues and actions on public lands are still thought of as being in the national purview, even though it is the locals and their landscapes that may be most affected. A well thought out national policy to better define the rules of civic engagement on matters concerning public land management might do much to sponsor grass roots ecological stewardship. Successful examples might help to rebuild social and political capitol, too. The spread of a grassroots civil dialogue based on real choices and real ecosystems, rather than false choices and ideology, surely would do much to restore faith in government and the principles of democracy. Our public land system once more provides us a unique opportunity, this time to show that government, citizenry, and science can work together to meet the social and economic challenges we face, while also finding a productive and sustainable relationship with our natural environment.

At its core, community-based ecological stewardship means that the human condition be understood as inevitably linked to the health of natural systems. But beyond that basic premise, it means reforming a system of thought and governance that evolved under very different circumstances. No doubt, there are many beneficiaries of what is now in place that will resist such change, but should proponents of the past decide our future?

In the end, it will not be possible to repair the human relationship with nature simply through law and regulation. Although those are still needed, of far greater importance will be to gain a social and cultural sense of responsibility to the natural environment. The current and ongoing decline of ecosystems and their natural processes should serve as a sign that deep and fundamental change is warranted in the relationship between citizens and their natural environments. That is not likely to happen without a fundamental change in the relationship and interaction between government and its citizens.

The multiple-use agency that began its transformation some 35 years ago is not the same agency it was back then. It now manages national monuments, wilderness, and a whole host of other programs not even thought possible back then. But neither are the people and communities the same; well, at least most of them are not. We should ask ourselves: In all those years, and with all of that change, is our relationship with the land and nature that much better? For that matter, what about our relationship with each other? If we cannot answer those questions in the affirmative, then it may be time to try something different.

> The past is our definition. We may strive, with good reason, to escape it, or to escape what is bad in it, but we will escape it only by adding something better to it.
>
> Wendell Berry; poet, farmer, conservationist

Chapter 18
Thoughts on How to Implement Citizen Based Ecosystem Stewardship – Experiential Knowledge from 32 Years in Governance

Richard Whitley

Abstract Two things my 32 years in public land management have taught me. First the complexity of the job has increased dramatically as resources decrease. The public lands have resources that the public depends on water, food, fiber, energy, recreation and aesthetics and the demand for these resources is increasing as are the conflicts and climate change will not make it any easier. The second thing is that the people who work for these agencies are professional, dedicated and committed to the stewardship of these resources. However many no longer feel they are making a contribution in spite of their best efforts. Much like the public they feel they are not listened to. People need to know they make a difference and the agencies mission is important. Both seem to have been lost. This chapter suggests some ideas that will help address this issue.

Keywords Collaboration • Stewardship • NEPA • Adaptive management Relationships trust building

1 Introduction

The federal governance model for natural resources agencies has changed little since they were founded beginning in the late nineteenth century. There have been many new laws, changing demographics, more litigation, increasing demands on a limited resource base, and now climate change and government deficits that must be addressed. The scientific management model of governance (introduced by Gifford Pinchot, America's first professional forester) with the government expert at the top of the pyramid served us well for many years but no longer can government be the

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sole determiner of what is best for all of "our" natural resources. The current system is slow to react, decisions when finally made are frequently litigated, and there are too many organizational layers, too many silos, too many administrative and organizational boundaries that inhibit effective collaboration and communication within government and with citizens. With current technology and the availability of information from experts outside of government processes can be implemented to mitigate these barriers and improve the effectiveness of natural resource management decisions. As we move forward into an uncertain future with increased demands and fewer resources government and citizens alike must begin looking for new tools.

We have reached the stage where government needs to engage citizens in a new way by bringing them into the decision making process.[1] Government alone can no longer do the management of complex social, economic and environmental systems. It will take collaboration between government and its citizens to successfully address the issues that face us as society.

We ought to establish a process of Citizen Based Ecosystem Stewardship because:

- The interplay of ecosystem, economic, and social issues affect the relationships between the health of a community and the health of ecosystems.
- Ecosystem, economic, and social issues are complex, interrelated, and defy easy, quick answers.
- These problems cannot be easily solved by any one person, sector, or organization.
- Neither agencies nor communities may have the resources to manage ecosystems and make wise decisions regarding natural resources alone.
- Citizens have the right to a direct and meaningful voice in issues that affect them.

White House Conferences, Secretarial Listening Sessions, Focus Groups, and individual comments from a diverse group of stakeholders on ways to achieve cooperative conservation have repeatedly concluded that federal agency staff should be "facilitative leaders and problem solvers" (Birkhoff 2006, 1). Slowly and sporadically some steps, primarily owing to the initiative of individual citizens and agency leaders, have been taken toward a more collaborative relationship between federal agency personnel and citizens. Yet, the facilitative role played by agency staff is not yet commonplace and a routine way of doing business.

Goldsmith and Eggers (2004) wrote:

> Government needs people with new network skills – collaborative skills are currently neither highly sought nor valued by government. Building such a capacity requires not only far-reaching training and recruitment strategies, but a full-blown cultural transformation: it requires changing the very definition of "public employee."

In this chapter I endeavor to address these issues from a practical, operational, and community level. These are my personal observations and experiences accumulated

[1] "I know of no safe depository of the ultimate powers of the society but the people themselves; and if we think them not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them but to inform their discretion." This quote from Jefferson describes well the need to move from a top down government control of natural resources to Community Based Ecosystem Stewardship as previously defined.

during 32 years in government. Recommendations herein are based on what I have discovered will work at the operational and community level. It was demonstrated to me early in my career that listening to our stakeholders can in fact facilitate action. A citizen came to the U.S. Bureau of Land Management (BLM) office with a large amount of data on tree plantations that BLM had been planting, replanting, and treating for a number of years. She asked why with our lack of apparent success to maintain a healthy stand of trees did we keep doing the same thing? Using computer technology more advanced than that available to us, she had developed some ideas based on data she and others had gathered and analyzed that she thought might be useful. Our first reaction was this person is not a forester, a silviculturist, or a trained scientist. What could she know? We were the experts. We ignored her help and she went away feeling angry and dismissed. Within a short time a notice of appeal was filed related to our silvicultural practices. In response to that appeal we found the data she presented had information that proved useful and improved our practices. Concerned citizens that had an interest in the land and in what we were doing collected this information. This collaborative relationship that integrated expert and local knowledge continued to develop and facilitated BLM's ability to take action.

In the following sections, I present my thoughts on governance, budget, law/policy, science, and relationships and how these impede or advance Citizen Based Ecosystem Stewardship. Full implementation of these changes would take decades. Yet over my 32 years in public service, I have seen incremental movement, which although imperceptible on an annual time scale, aggregated over time results in substantive change.

2 Governance and Citizen Stewardship

The challenge created by the magnitude and speed of ecological, economic, and social change brought about by human activities occurring across the west can only be addressed with a combined effort from federal, state and local government, private organizations, and the communities most directly affected. Meeting the challenge to harmonize the ecological, social, and economic systems will require a much more flexible and adaptive approach to the management of our natural resources and our organizations.

Current governance structures do not allow for the kind of organizational flexibility needed in these times of rapid change and uncertainty. The current model of planning processes, project design and implementation, monitoring, appropriations/budget processes, reward systems, delegations of authority, and the hierarchical systems stifle innovation and creativity. Further complicating the situation, these outmoded systems and processes make it difficult for the private sector and local communities to work with the federal agencies.

Many of these issues can be partially addressed in the short term within current law and regulation; however, true long-term fixes will take changes in the law, regulation, policy and culture. It will take truly transformational leadership. We need to think about governance in completely to new ways. There still seems to be the assumption within government that if we keep fine-tuning the current traditional methods and approaches, we will achieve the desired results. However, one of the complaints I hear most often from employees, citizens, and stakeholders is nothing ever really changes no matter what the new organization looks like or is called.

After 32 years in government and seeing repeated attempts to address these issues by more analysis or another reorganization. I have concluded that the problem is not simple reorganization. We need to identify and treat the "disease" underlying the symptoms. The question is rarely asked why the last reorganization did not work or the last task force report did not get implemented or if it was implemented what were the results. Often another reorganization is undertaken to address the same symptoms, which are reoccurring, especially if the administration has changed and new leadership is installed in the bureau. Moving organizational boxes around gives the impression of activity and decisiveness without any real change occurring. Changing organizational structure without diagnosing the underlying causes of the problems only creates more problems and lowers morale. Very little has actually changed as a result of reorganizations I was involved in. Over the last decade the Bureau of Land Management has reorganized the Washington Office, and Centers, Field Offices from a three tier organization to a two tier and back to a three tier, which caused a great deal of disruption with little or no improvement in service delivery. To address the current and future complexities agencies must make some fundamental changes. In most cases reorganizations and other organizational change have come from the top down with little attention to mission. There is a fundamental question that is rarely asked: "What, how and by whom can the agency mission be best delivered in the complex and rapidly changing environment in which the agencies currently and will continue to operate in the future?" In other words, the agencies need to re-examine fundamentally their mission, purpose, and relationship to the citizens they serve within the context of the twenty-first century. This re-examination requires congressional, political, and public guidance and support.[2]

The mission of the Interagency Cooperative Conservation Team (ICCT) comprised of federal agencies within the departments of Interior, Agriculture, Commerce and Defense was to focus on improving interagency collaboration and citizen stewardship. The ICCT was successful in developing collaboration competencies, collaboration training and development strategies, performance measures. These strategies were developed from feedback received from stakeholders listening sessions held across the county and at the White House Conference on Cooperative Conservation held in St. Louis in 2003. Few of the lessons learned have been transferred into the routine business of these agencies. The interagency collaboration worked very well within the ICCT but did not transfer substantively beyond the individual members of the group. As I continue to work with community groups, I hear the same complaints that I heard as a member of the ICCT. Many personnel at the operational levels of agencies that comprised the ICCT were never aware of its existence and the results of its efforts. To my knowledge no final report was ever published for general distribution

[2]Note the observation of a citizen that the federal agencies are irrelevant in Chap. 22, ms. p. 11.

to agency personnel. In those cases of which I am aware that new competencies to foster collaboration were specified in new position announcements, the actual staffing of that position continued to reflect the standard practices and traditional competencies. The same situation applied and continues to apply to annual performance standards for agency personnel. By and large, the opportunities within the land management and natural resource agencies to engage citizens as stewards of the land are still dependent upon on the willingness and leadership of individual managers.

Even though, federal land management agencies to date have been slow to evolve toward embracing citizen stewardship groups as equal participants for managing natural resources, there are many examples of these groups across the land (several hundred of them participated in the White House Conference on Cooperative Conservation).[3] The Applegate Partnership is one of the long-standing and well-documented success stories. It started when local environmentalists and loggers became frustrated by the continuing animosity generated by the conflict over harvesting of timber and preservation of habitat. A collaborative effort developed brought together a range of stakeholder that included BLM and the Forest Service to work together to address the conflict through a constructive process. Out of that effort has come thousands of acres of forest restoration on public and private land, a volunteer fire department, the community management of a county park (managed at a profit), a newspaper and a great deal of social capital. The Small Diameter Collaborative, another community driven collaboration with the BLM and Forest Service, formed 5 years ago to address forest health issues recently completed an ecosystem assessment for all the Rogue River Basin. All parties that include industry, environmental groups, and agencies have endorsed this effort. The next step is the implementation of some new restoration practices on a 50,000 acre landscape. There are other similar efforts around the country. Most have emerged organically at the grass roots community level with only a few initiated by agency leadership.

Although some progress has occurred, there are still numerous obstacles to these successful collaborations which include: (1) appropriations/budgeting and a political process that create disincentives for greater stakeholder involvement; (2) most agreements with stakeholder groups are long term projects and stakeholders are reluctant to commit their resources if the project will only be funded for 1 year; and (3) agreements reneged on by political and agency leaders after years of good faith negotiations – potential political and constraints to the decision making process need to be discussed at the beginning of the process.

Changes in how we govern can be influenced by new technologies that are beginning to enable innovation, through seamless collaboration, discussion, and interaction. These collaborative technologies could better integrate agency and stakeholder activity. These technologies can potentially transcend structure and support interagency and stakeholder dialogue, information sharing and learning helping to structure new institutional arrangements.

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[3]Refer to Chap. 22 for a more complete discussion of the barriers, challenges, and progress with regard to federal agency/citizen stewardship collaborations.

It seems that we in the agencies sometime lose sight that governance is not just about those that govern but the governed. We must invest in place-based capacity building (training) that includes agency and stakeholders together. The training ought to include conflict resolution, joint problem solving, joint fact finding and other skills needed to support changes in the governance model (see for example, Karl et al. 2007). The BLM Partnership Series of courses and workshops is an excellent example of place-based, citizen capacity building (see Appendix X for history of the Partnership Series).

3 Budget

In a time of limited resources, when agencies should be working together and sharing resources, there is in fact an increase in competition between agencies and within agencies that leads to redundancy and wasted resources. Owing to politics and special interests which include special interests within the agencies, The current federal appropriations and budgeting process at least as it relates to the management of natural resources is not structured for addressing long term restoration, resilience, or adaption strategies. The Government Performance and Results Act as it applies to natural resource management is not measuring actual improvement in ecosystem conditions but the number of projects completed. A change in focus to actual improvement in ecosystem health, resilience, or adaption to climate change as well as community well-being will create an incentive to move to an ecosystem approach to management.

In this era of climate change and increased demands from the public lands, the federal budget strategy needs to create incentives for agencies to work collaboratively across organizations and landscapes and include provisions for private land holders to be involved. Aldo Leopold's (1949, 213) comments on government-funded conservation are as true today as they were then:

> Government ownership, operation, subsidy, or regulation is now widely prevalent in forestry, range management, soil and watershed management, and migratory bird management, with more to come. Most of this growth in governmental conservation is proper and logical, some of it is inevitable. That I imply no disapproval of it is implicit in the fact that I have spent most of my life working for it. Nevertheless the question arises: What is the ultimate magnitude of the enterprise? Will the tax base carry its eventual ramifications? At what point will governmental conservation, like the mastodon, become handicapped by its own dimensions? The answer, if there is any, seems to be in a land ethic, or some other force which assigns more obligation to the private landowner.

For more effective collaboration among agencies to manage natural resources and ecosystems, funding could be pooled at the departmental level. Agencies and stakeholders using consensus based decision-making practices collaboratively would build strategies for how they will work together to address ecosystem and community health issues. Then each agency would apportion funding to address their part of the strategy. The Obama Administration's Race to the Top competition for education might serve as a good model. "The theory behind the Race to the Top competition is that with the right financial incentives and sensible goals, states, districts and other stakeholders will forge new partnerships, revise outmoded laws and practices, and fashion far-reaching reforms" from an editorial by Education Secretary Arne Duncan. This concept can also apply to natural resource management agencies. Congress by providing a pool of money that focuses the federal government agencies on working across organizational boundaries and working more effectively with state government and local government and stakeholders can improve resource outcomes and reduce inefficiency.

4 Law/Policy

In the last 5 years many legislative natural resources acts and executive orders mandate that that agencies work collaboratively with citizens and each other. Why have they not made more progress? In many cases what is called collaboration is in fact coordination, cooperation, or outreach (informing and educating). Coordination and cooperation are more about providing information on an activity and getting input after the agency has invested what often amounts to substantial resources. At this point it is difficult to make changes. The public's perception often is that agency decisions were already made and they wasted their time proving input. This is the typical agency planning process and is confused with collaboration. Collaboration is a process in which interested parties, often with widely varied interests, work together to seek solutions. Collaboration is stronger and makes for more sustainable decisions than cooperation or coordination because it requires a shared responsibility and shared power among the stakeholders.

It is often argued by agency leaders that collaboration takes too long and is too costly. It is true the upfront costs can be greater, however if the collaboration leads to more sustainable decisions the long-term costs can in fact be less. The agencies also have to deal with short time frames driven by the appropriations process. The appropriations process is focused on acres or numbers of treatments vs. authorizing committee's visions of collaboration. Agency field staff must spend fiscal year funding within that fiscal year. Within that time they just complete designing and planning projects for a given number of acres or miles or facilities, etc. Given these constraints they will not take the time to collaborate internally much less with external stakeholders. They do what gets measured. This reality not only reduces stakeholder involvement but also impedes a true ecosystem-based management approach. When projects are completed according to performance measures, the agencies claim success and are awarded with additional funding the next appropriations cycle. Performance measures overwhelmingly are defined by easily quantifiable criteria (i.e. numbers of acres treated). Criteria to involve stakeholders in a true collaborative effort and take a systems approach by integrating the natural, social, and economic systems usually are not part of employee performance standards.

There is a belief for many in the agencies that the procedures set forth in the National Environmental Policy Act (NEPA) and their planning processes are sufficient to address public involvement. This is true. However, the agencies often conflate public involvement with participatory collaboration. In so doing, they claim that they are engaging citizens in a collaborative process. Moreover, the agency focus is almost entirely on section 102 of NEPA, which lays out procedural requirements for assessing environmental impact and planning. They tend to ignore section 101, which states:

> It is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.

This statement implies that agencies have a great deal of latitude and a responsibility to engage citizens and other institutions in processes that fully engage them in the planning and implementation of actions.

One of the things I have heard from many agency leaders is "if we collaborate will you guarantee no lawsuits". Perhaps the question should be rephrased: "can collaboration reduce the likelihood of a successful lawsuits?" Consider the case of the listing of the Lesser Prairie Chicken. A number of environmental organizations had notified BLM and US Fish and Wildlife Service that they planned on filing a lawsuit to force the listing of the Lesser Prairie Chicken. After receiving the notice, the agencies developed a strategy to engage the environmental organizations, oil and gas industry, livestock industry and others in an effort to design restoration plans that would prevent the listing. To date this agreement has led the restoration of thousands of acres of Lesser Prairie Chicken habitat on public and private lands with contributions from all the stakeholders.[4] If this collaboration had not occurred it is likely the Lesser Prairie Chicken would have been listed with significant economic impacts.

Lawsuits are a tool for the public to hold government accountable; they can be misused but they can also help government do its work better. Many lawsuits are generated as a result of people feeling they have no power that is to say that they did not have a say in the decision that was made. Real collaboration "Citizen Based Ecosystem Stewardship" is ultimately about power sharing. Federal agencies almost always interpret 'power sharing' or consensus based decision-making as abrogating their legal and statutory authority. This is not the case. The agencies retain their legal and statutory authority to make decisions when they involve stakeholders in collaborative process. The only difference is they agree to make a decision arrived at by the group. The Federal Advisory Committee Act (FACA) may come into play in this regard. Even so there is more latitude in the interpretation of FACA then agency employees recognize. Agencies can unquestionably empower citizens by involving them in decisions without negating their authority and compromising their accountability.

The majority of laws governing natural resources, ecosystem restoration, and preservation, and the environment today were enacted in the 1960s and 1970s. This was before the development of concepts such as adaptive management and

[4]The reader can access a short history of the consensus building process at http://cbuilding.org/publication/case/protecting-lesser-prairiechicken-and-sand-dune-lizard-new-mexico

ecosystem-based management and best practices of collaborative decision making. It is time to reexamine those laws in light of what we have learned over the past four decades. Are the laws of four decades ago designed to protect the environment and our natural resources unintentionally now contributing to degradation of the environment and natural resources by impeding the ability agencies to protect these resources and the citizens to steward them?

5 Organization

The current stove piped and hierarchical structures of natural resources agencies are simply outdated and unresponsive to the rapid changes occurring today; social and collaborative learning is inadequate, and information sharing across boundaries insufficient. The budget and performance measures systems set up a competitive process. Sharing of resources or innovation is not rewarded, in fact, there are serious disincentives in the system. If a unit or program has a savings at the end of the year it is frequently given to another unit or program that may have run a deficit in order for the whole organization to balance its budget. There are few consequences for over spending and few rewards for saving. Performance measures are a necessary tool but currently not focused on systems outcomes but on programmatic outputs. As a result each level of the organization and program competes for resources and tends to expand its own position at the cost of the rest of the organization. As budgets become more constrained in difficult economic times, competition between agencies and within agencies increases. On one hand, competing for a limited resource could generate creativity and innovation. On the other, it could thwart creativity and generation, because competing units fail to see the power of combing their resources through collaboration. It is not uncommon, in an attempt to mitigate discontent, to allocate a small portion of the funds to many competing entities. This neither satisfies the competing entities nor provides them with sufficient resources to accomplish their missions. Those allocating the resources must make difficult decisions that ought to include cutting projects or programs to concentrate funding on a few priority activities.

The land management agencies pride themselves on being decentralized but experience would indicate that operational managers are frequently the decision maker in name only. Delegations of authority are frequently at a level or two above the manager on the ground. When the delegations are at the field level many managers feel they must consult with the level above out of fear of being over ruled. At minimum, this lengthens the time to make a decision. It also sends a signal to the field manager that she or he does not have the trust of those at higher levels. One consequence of this is that citizens ignore the field level manager, diminishing a collaborative relationship, and seek a decision at a higher level. Managers need to keep their supervisors informed. But they ought to have the authority to make place-based decisions that are in accord with the agency's mission. These operational managers need to be selected and trained, at least in part, for their ability to make collaborative and innovative decisions. They should be allowed to take risks, knowing that they will be held accountable for their decisions. The current reward structure does not encourage risk taking.[5] Yet, creativity and innovation require high tolerance for risk.

Many of the tools are in place to address these issues, but they do not seem to be implemented. The natural resource agencies have made significant investment in building competency-based resource management systems, and the individual agencies generated plans for integrating collaboration skills into their recruiting, hiring, training, performance appraisal, rewards and incentives, and retention. However, progress has been slow and many citizens state that there has been little change in their relationships with the agencies. Over the last 4 years I have talked to numerous government employees who have been involved in collaboration and few have been recognized for their work with stakeholders. These efforts are not part of their performance standards, and, thus not recognized during the employee's performance evaluation. The BLM developed a joint fact finding training that has never been used and its innovative Partnership Series, which had many successes, is no longer used.

Clark and McCool (1985) identify a need to integrate experts in conflict resolution into the public workforce, including social psychologists, sociologists and political scientists to help forge consensus among stakeholders (Clark and McCool 1985). Yet, the natural resource agencies are still hiring the same skills as 30 years ago. In addition to the traditional skills, new skills must be added for resource agencies to meet future demands. When sociologists and other personnel trained in other non-traditional fields and disciplines are hired they are generally in research or at Regional and National offices developing policy and reviewing planning documents. They are not placed in the field where their skills would help develop collaborative relationships with communities. Many leave after a short time unfulfilled, because they want to actually put their skills and knowledge into practice at the community-level. The BLM's National Riparian Service Team, described in the following section, is an example of a multi-disciplinary work force aiding management decisions that integrated natural science, social science, and economics.

In addition to hiring the non-traditional discipline specialists, the agencies need to hire the traditional specialist (range, wildlife, forestry etc.) that has training in conflict resolution, problem solving, facilitation, and negotiation. To be able to successfully implement plans or projects they will need to work with other experts and stakeholders with differing opinions, be able to tell their story to disbelieving stakeholders and be able to work with these stakeholders to develop solutions that are supported and can be implemented. The era of the agency scientific expert as the sole determiner of the outcome is over; the "expert" needs to be multi-faceted.

In summary, over the last 12 years the agencies have tried to incorporate collaboration skills into recruiting, hiring, training, performance appraisal, rewards and incentives, and retention. Why have these attempts not had more impact? One reason is that the institutions and how they fundamentally function have not changed. New institutional arrangements and philosophies of governance must be explored and tested through demonstration projects. These projects must be funded at sufficient levels and allowed sufficient time to develop and mature. Not every strategy will work, but it is

[5]Chapter 22 discusses this issue at great length.

crucial that we learn from every failure and success. Although, the "freedom to fail" has been advocated by teams such as the Interagency Cooperative Conservation Team, failure is not still an option for advancement, and, thus scientists and mangers are blocked from attempting leaning experiences that could provide valuable insights.

6 Science

> Science is useful as a form of systematic critical enquiry into the functioning of the physical world, but it is not a substitute for political judgment, negotiation and compromise.[6]

The federal government used to be the major source of scientific information about public land resources. The proliferation of accessible and reliable information about public lands from non-governmental sectors has augmented government-supplied knowledge, and created a more open environment for information sharing. Wondolleck and Yaffee (2000) call this trend the "democratization of expertise." In spite of this there has been reluctance on the part of agencies to consider or incorporate non-government science into the decision making process, therefore missing opportunities to learn and expand their knowledge base. This is particularly true of local knowledge, which is frequently dismissed with no consideration.

The resistance to incorporating non-governmental science and local knowledge with government expert science along with the lack of a working relationship between scientists and management in natural resources were two of my biggest frustrations as a government manager responsible for implementing the science. Both scientists and managers are equally to blame for the lack of coordination and communication between them and citizens (the failure to incorporate local knowledge). Neither scientist nor managers can solve today's complex problems without working together in partnership with stakeholders.

There is also an increasing skepticism among the public about science. This I think can be attributed to an elitist attitude among scientists who are unwilling to work directly with stakeholders in problem solving.[7] They assume that science has all the answers and that they are the experts. In their minds the public is ignorant and the solution to use science more effectively in societal decisions is simple: just educate the public and finally they will understand. It's not that simple as many more factors are part of a decision; science is only one factor and often not the deciding factor. When science is used as a tool to help people solve problems rather the solution the reaction can be very different. To assume that decisions based on "best science" are always correct is a false assumption. We all look at data through different filters that impact our interpretation of the data therefore our assumptions.

Often experts analyzing the data come to very different and apparently contradictory conclusions. These contradictions often lead the public to conclude that

[6]Michael Hulme, University of East Anglia RSA Journal.

[7]An example of the mistrust of science by citizen groups is described in Chap. 1.

scientific and technical analysis is really no better than "common sense." Expert application of the scientific method can yield important information, provided that the experts understand the role of technical facts in the larger context of the problem and decision-making process. There are tools available today that can facilitate an improved interaction between scientist, management, and stakeholders. Joint Fact Finding is another tool that has been under-utilized for science disputes, which underlie most natural resource conflicts. This is a component of a consensus-seeking process that brings scientist, decision-makers and stakeholders together.

Many of the tools to implement a more citizen-based approach to management are in place and we need the will to move forward. We need to recognize not everything we try will work and whether it works or not we need to learn from what we have done. All plans invariably have unintended consequences or unanticipated outcomes; no plan is perfect. We need to "start and manage the drift."[8] The important thing is to learn and adapt as we move forward.

Many agency employees and stakeholders at the field level believe the natural resource managing agencies have lost sight of their mission. Some of the tools mentioned in this chapter can help improve the agencies' capabilities to work across boundaries, and increase focus on improving ecosystem, and community health. To address the changes that must be made we need to demonstrate to agency employees and stakeholders what they have to gain and what they do has meaning. Agency employees are dedicated and hardworking but many have lost passion for their work because they are frustrated by the continuing degradation of natural resources and the slow pace of change. It is important to keep meaning upfront because people gain energy and resolve when they know what they do contributes something beyond themselves. The recommendations made here will help agencies and stakeholders work together and gain meaning form the work they accomplish together.

To sum up, many of the methods and tools for natural resource and land management agencies to evolve toward collaborative decision-making processes that enable adaptation to changing situations are available and in place at many agencies. These methods and tools are not commonly used because of the inertia and risk avoidance inherent in bureaucracies. Leadership is important to foster an environment for change and to generate the momentum to change. Characteristics of change-leaders should include risk-tolerance, willingness to learn from the past without staying mired in the past, and willingness to share power to empower.

7 A New Model

> You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete.[9]

[8] This phrase is attributed to Carl Moore, a facilitator and community organizer.

[9] Buckminster Fuller.

The National Riparian Service Team (NRST) a BLM partnership with the Forest Service and the U.S. Fish and Wildlife Service is an example of an interagency team devoted to on the ground collaboration with multiple stakeholders. The NRST provides the leadership to a network comprised of teams and individuals with federal and state agency, non-government organization, university, and private citizen affiliations that are implementing riparian restoration strategies at the state and regional level. The team is composed of a hydrologist, ecologist, fisheries biologist, range scientist, wildlife biologist, riparian specialist, and other resources specialists and uniquely a social scientist and conflict management specialist. Their approach is to address riparian restoration issues by bringing science to the stakeholders and facilitating their ability to solve the problem using the latest research and local knowledge. They bring a high level of technical expertise and at the same time recognize that all science is applied in a social context. Therefore all their work is place-based. Another unique aspect of the NRST approach is a third party regularly evaluates their work. This is a model that is helping to move governance and policy toward collaborative decision-making. It should be replicated, yet the NRST remains unique and continually struggles for resources.

The NRST brings the science to the people who have to live with the results of the decisions driven by the science. The scientists and managers work directly with stakeholders to develop solutions. They do not come in with the science and the solution and impose it. At the same time the stakeholders learn more about the resources, the scientists learn more about the local conditions, history of use and communities and managers have decisions they can implement in collaboration with stakeholders. Scientists, managers and stakeholders can then learn together and jointly form further research questions that help fill in the gaps of knowledge. This same approach clearly can apply on a much broader scale. An interagency team of “experts” works with local stakeholders to address natural resource conflicts. This is time consuming and requires the agencies to do business in a different way. It will require a new mindset and a cultural change within the agencies.

In recognition of the uncertainty inherent in natural processes and the need to deal with this uncertainty in natural resource management decisions, the agencies adopted the principles of adaptive management (Holling 1973; Walters 1986). Unfortunately, the principles in the majority of cases were not applied properly (particularly the provision to monitor and evaluate) and only a handful of adaptive management cases have been successful. The Department of the Interior published, “Adaptive Management: The U.S. Department of Interior Technical Guide,” in 2007 (Williams et al. 2007). This guide attempted to align adaptive management with structured decision making. The first activity of ten in this approach is: “Engaging the relevant stakeholders in the decision making process” (3). This is a tenet of collaborative adaptive management (CAM). In my view, adaptive management (AM) should be a collaborative process. We need to evaluate its appropriateness and effectiveness under different conditions and settings in order to optimize its use in practice.

As we move more and more toward resolving resource conflicts at a landscape level we will be attempting to address multiple, and often conflicting management objectives, constrained management capabilities, dynamic ecological and physical systems and uncertain responses to management actions. These aspects, almost by definition, are critical considerations for an adaptive approach. Yet there is much we still need to learn about AM in order to further invest in it. An emphasis on resilience, adaption, restoration and partnership in combination with the AM, and other tools will help bring a sharp focus on these complex issues and will help stakeholders at all levels federal, state and local governments, and other affected stakeholders move forward with in improving resource condition, and community health.

Four years ago a group comprised of representatives of BLM, USFWS, USGS, U.S. Institute for Environmental Conflict Resolution, Meridian Institute, Sonoran Institute, National Policy Consensus Center, The Nature Conservancy, and Adaptive Strategies met to develop a strategy to implement an AM strategy that would address many of the issues address in this book as well as assessment of previous AM efforts. The focus of the proposal was the integration of science, policy, and decision-making. A strategy for shared and continual learning was at the heart of the effort. An outcome of the meeting was to establish an AM Learning Lab a forum to implement, analyze, and share the lessons from joint AM pilot projects among BLM, USGS, USFWS, and USFS in partnership with communities and state and local partners.

The overall goals of the Adaptive Management Learning Laboratory are to:

1. Evaluate how adaptive management can be implemented more effectively in natural resource planning, assessment, and management, in order to better understand its benefits and challenges.
2. Enable broader learning and institutional change to encourage the development of more effective resource management and governance strategies.

The key components/principles of the learning lab approach would include:

1. A commitment to high quality scholarship and analysis (including literature review, case analysis, pre-project assessment, etc.). It is important for us to learn from previous work why some efforts have been successful and others have not. There has been a significant amount of evaluation done on CAM approaches from an ecosystem and social/cultural standpoint. However, evaluations should be results-based and define success in the context of how decisions (adaptations) were based on active learning. Interns from one of several universities with which agencies have agreements can conduct this evaluation.
2. A multi-stakeholder commitment to iterative goal setting, hypothesis testing, and monitoring and evaluation.
3. Interagency and multi-party collaboration in planning and development of the learning lab.
4. Active stakeholder participation (in project assessment and design, analysis and learning, communication and feedback, institutional change).
5. Meeting and building upon agency guidance and ongoing programs (e.g. phases of program development and problem-scoping key, see below).
6. Learning results in improved decision-making, management, and governance through expanded capacity.
7. Sustained resources and institutional commitment.

The AM learning model:

1. Assess ->Design ->Implement ->Monitor ->Evaluate ->Adjust ->Re-assess

8 AM Learning Lab Structure

The learning lab would build upon the structure described below and should make explicit the processes designed to capture, document, translate and disseminate learning from the pilot projects.

National/Regional Oversight Group

- Oversee implementation of AM Learning Lab.
- Plan application of learning and results from the lab projects
- Coordinate inter-organization efforts and projects
- Remove institutional barriers
- Provide policy oversight and changes if needed
- Provide research, scientific and technical support
- Connect site-specific work and management efforts to the regional and national level

Program Evaluation and Monitoring Group (multi-site)

- Convened by a NGO to address FACA issues and assure a high level of stakeholder involvement throughout the process
- Facilitate opportunities for learning across projects – interactive website and listserv, regular conference calls, cross visits, periodic workshops
- Create a website for sharing information about all projects (process and content)
- Make social networks available to store and share information with a wide audience
- Publish lessons learned and proven practices
- Provide forums for trouble-shooting
- Develop and test hypotheses about success factors
- Identify needs, patterns, and opportunities for change
- Provide recommendations to the National Oversight Group

Project/Site Level Groups

- Establish co-learning relationship between agencies and non-governmental interests
- Create a transparent process for sharing data, jointly assessing/interpreting it and communicating it beyond the group
- Synthesize existing pre-project research
- Collaboratively set management objectives and develop models
- Identify critical issues, hypotheses to be tested, project scope/scale
- Decide who will conduct monitoring and evaluation (options include: joint fact-finding, third party, and agency)

- Ensure data is available in a form that is accessible and useful to everyone
- Ensure that stakeholders are partners in assessing and making decisions about the data
- Transfer lessons learned to Program Evaluation and Monitoring group for transfer to other groups

9 Most Importantly: It's All About Relationships

The subtext of much of what I have suggested above is it is all about relationships. Agency staff and stakeholders focus on the rational and avoid the emotional even though emotion drives many resource conflicts. As much as we would like to believe we could solve all resource problems by shear rational argument, we need to acknowledge that values, cultural norms, and worldviews complicate decisions. We need to engage diverse stakeholders in a conversation. In 1992 during the height of the "timber wars" in western Oregon, Jack Shipley, an environmentalist, and Jim Neal, a long-time logger, did the unthinkable they began talking to one another. By being willing to start that conversation these two unlikely collaborators planted the seed for what rapidly grew into the Applegate Partnership. This partnership is still active today and has not only improved forest health but also increased social capital in the Applegate Valley.

Within and between organizations I have seen time and time again someone from one program attack someone form another program or agency when they disagree. Peoples' positions harden and progress stalls toward reaching a mutually beneficial agreement. Yet, when people work together, go to the field together, and share their ideas listen to one another without judgment the relationship changes and problems get solved and work gets done.

The future health of ecosystems and communities that rely on them is dependent on decisions made in the next few years. We have choices: we can choose to continue on the path we are on that most would agree is not moving us forward or we can choose to work with each other and build relationships. We need to develop a common vision for our future. These will not be easy choices but they can be ours to make together. Your *attitude* toward other individuals or organizations can make the difference between destroying a relationship or building a relationship of trust and understanding based, in part, on acknowledging the legitimacy of other viewpoints even though you may not agree with them. Trust takes time build and it must be built upon respect for one another.

A rancher in Arizona in a public meeting with an agency told a story about trust that changed the direction of a conflict. He trained his horses himself by looking for what they do right and rewarding, patience, and understanding, the horse from a horse's point of view. It did not take long before that animal was a reliable trusted companion. He also said that when he was younger he would train horses by the older, conventional way using force (called breaking). He said that either method got results. But there was an important difference. He could never trust an animal trained by the force method. He could always trust the animal trained by the behavioral method, because the training was collaborative between the horse and him based on respect.

We might learn from this rancher. We can force people to do something by using the regulatory "hammer" or we can work with them collaboratively to accomplish the same thing. Which might be more likely to result in effective policy that is durable and engenders a nation of citizen stewards?

Failure is not fatal, but failure to change might be.[10]

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Chapter 19
Climate Change and the Language of Geographic Place

James A. Kent and Kevin Preister

Abstract This chapter describes a process of human geographic issue management, which is based on implementing a grassroots movement, to address climate change. Most climate change adaptation initiatives are driven from the top down. Yet, it is universally agreed that adaptation to climate change is local and place-based. It is essential to honor the local cultural and social norms in any initiative. Knowledge at the local level can be incorporated into a climate change adaptation plan. Such knowledge can be aggregated upwards to higher geographic scales. This process empowers citizens and supports citizen-based stewardship, which is the key for adapting to climate change and achieving sustainability.

Keywords Social ecology • Social justice • Human geography • Social capital Place-based language • Citizen empowerment • Human geographic issue management system (HGIMS) • Informal cultural systems • Social capital • Emerging issues • The Discovery Process • Bio-social ecosystems

1 The Premise

As the scientific reality of global warming sets in across the planet, government agencies, non-governmental organizations and corporations at all levels are responding with ideas for projects, programs and policies that will reduce our carbon emissions.

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Policy strategies are being debated at the highest levels of government[1] and in many international forums, such as the United Nations Climate Change Conference in Copenhagen in 2009. All federal agencies, including the Departments of Energy, Interior, Agriculture and the Environmental Protection Agency have policies addressing global climate change and are actively adjusting their field programs.

The Union of Concerned Scientists in 2009 issued a report of their "blueprint" for addressing global climate change.[2] It sets forth policies designed to meet a variety of targets for the reduction of greenhouse gases. Missing is the social component, a critical aspect of any policy process that recognizes the current practices of everyday citizens in dealing with climate change. The social component that recognizes citizen based stewardship as necessary to addressing climate change consistently appears to be "beyond the scope" of works such as this 2009 report, as well as the many federal programs that only recognize a top down solution to be considered. This top down bias ignores the essential success that a bottom up approach can provide.[3]

Sensitivity to local geographic living conditions and to place-based language people use to describe their current individual practices to increase carbon-free livability is vital to increasing citizen participation in these large-scale policy initiatives. A central challenge for a new approach to global warming is the creation and integration of scientifically valid and culturally appropriate policy strategies for addressing carbon emissions. If we as a global society are unable to link the formal institutions with the informal systems of communities concerned with survival and caretaking, the policy choices will by default become regulatory, draconian in their consequences, high in political and monetary costs, and limited in their effectiveness.

In this chapter, a human geographic issue management system is described to honor what people are already doing in their local areas to address climate change. Building programs and policies from a human geographic perspective as a means to enhance success is illustrated through a unique mapping technique. We discuss the limits of top-down initiatives and how honoring and using the language of place is the key to implementing a grassroots initiative. An implementation model that has been successful in other settings is discussed through illustrating the six scales of human geographic mapping that can be used to aggregate action from the neighborhood to the global level. Also discussed is why initiatives that build on action begun at a local level permits successful aggregation to higher levels in order to create healthier societies and a healthier planet. Finally the conceptual framework and methodology of applied social change is presented as capable of fostering citizen-based ecological stewardship that leads to empowerment and mobilization to participate in the changes embodied in emerging carbon-free policies.

[1]Lizza R (2010) "As the World Burns: how the Senate and White House missed their best chance to deal with climate change". *The New Yorker* October 11, 2010:70–83.

[2]Union of Concerned Scientists (2009) "Climate 2030: A National Blueprint for a Clean Energy Economy." Union of Concerned Scientists, Cambridge, May, 2009.

[3]Although key officials in Virginia dispute climate change information and resist climate change policies, residents in Norfolk, at the mouth of the Chesapeake Bay, routinely struggle with and work against rising tidal streams on three sides ("Front-Line City in Virginia Tackles rise in Sea" *New York Times*, Science Section, November 26, 2010).

2 The Limits and Risks of Top-Down Initiatives and the Importance of the Language of Place

Just as the energy picture varies by geographic region[4] in terms of energy demand and development choices, so the solutions to global climate change are also geographically based. Accounting for cultural factors in designing climate change policies means that policies will be unique in each human geographic region. For example, in an effort to reduce air emissions, Mexico City in 1989 copied U.S. strategies including "no drive days" determined by the last digit of the license plates. While the policy was intended to encourage people to take the Metro, instead wealthy people bought older second cars to drive on restricted days. These cars were usually more polluting, thus adding to the air emission problems.[5] Instead of importing programs from elsewhere, policy makers should learn the local issues and how they are managed by citizens in order to incorporate these cultural practices into policy directives to avoid unintended consequences.

The current crop of global climate change initiatives derives from a failure to understand how social change actually takes place. To understand social change, two systems in society are recognized: the formal and the informal. The formal world is made up of organizations and self-interest groups that are politically, ideologically and economically oriented, while the informal world is made up of individuals and families who must survive on a day-to-day basis, take care of each other, and maintain their culture in a geographically-defined area.

Al Gore's internationally acclaimed research and presentation of the documentary, *An Inconvenient Truth*, pulled the disparate parts of various quantitative and qualitative sources of information on the warming of the globe into a comprehensive package generating a consolidated focus. Advocates were then trained to take the package to go and sell the idea of climate change to the masses. At some point in that selling process, a shift needed to occur, a shift from just a centralized approach of imposing the idea of climate change, generally using scare tactics, to a decentralized, more balanced face-to-face human scale approach. The decentralized approach could have engaged citizens to discover the elements in their own lives and environments that were of specific concern to them regarding the effects of the warming of the atmosphere. A base would have been built as people discovered what they were currently doing individually in their daily lives that affected the issue of climate change. Because this shift did not occur where citizens could become involved from their own experiences, and defend their experiences to a wider public, the door was open to skepticism and suspicion about the scientific validity of climate change generated by particular political interests at the national level. Had citizens owned the climate change issue by that point, the subsequent disinformation campaign would not have been nearly so successful.

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[4]Lizza, ibid, p 72.

[5]Bohren L (2009) "Car culture and decision-making: choice and climate change," In: Crate SA, Mark N (eds) Anthropology and climate change: from encounters to actions. Left Coast Press, Walnut Creek, pp 370–379.

A shift of major proportions will soon have to take place in the centralized narrative and organizational structure to one of engaging the American people in addressing their "self-interest" in this issue at the neighborhood, village and community levels of society. For instance a McClatchy-Ipsos poll in December of 2009 indicates the following:

- 70% of Americans think global warming is real;
- 61% think that it is happening because of the burning of fossil fuels;
- 69% support Cap and Trade legislation, even if it costs them $10 a month more, as long as it creates a "significant" number of American jobs.[6]

Note the language in this poll that taps one of the informal grassroots issues: *"creates a significant number of American jobs."* Policy makers engaged in formal "top-down" approaches do not seem capable of recognizing the ability to grow an issue from the bottom-up. American jobs are the central focus of the citizens and that has been lost in arguing the ideology of cap and trade.

Explanatory science often is a trap to social action because it is based on "imposed rational" thinking. Imposed rational thinking is recognition by the scientist that the truth has been found and, since it is true, then the recipient should recognize it as such and act accordingly. Thus communication is conceived as one-way: If the scientific facts are known, it is assumed that people will act accordingly and change their behavior to align with the facts. By only using a formal approach where there is no interface with the language and geography of a community allows for the issue to be polarized at very high levels, where dueling scientists and political pundits take ideological control of the issue.

2.1 The Food Industry and the Grassroots Movement

A good example of a movement where a shift has taken place is with the food industry and the grassroots citizen demands that the food industry change its ways of producing poultry, beef and pork. Citizens began their movement with a central theme of "factory farms," which was a grounded, more effective way of tapping into and using local language than "climate change." Using the term "factory farms" allowed a contrast with the term "family farm," a visual image with which ordinary Americans could identify – a pastoral image of family farms and the lifestyles of farmers as exhibiting solid American values of hard work and taking care of family, neighbors and community. The visual image of "factory" is one of mass production, and with a few well-placed pictures and statements, the image of "factory farms"

[6]McClatchy-Ipsos Poll (2009) "Poll: most Americans support climate change if it creates jobs," *Dallas Morning News*, December 10, 2009.

began to include meanings of inhumane treatment of animals and unhealthy outcomes for humans.[7]

From this beginning, the movement concentrated on geographic areas where factory farms were prominent and could easily be viewed and documented. Local individuals could be engaged in making the discoveries of the unhealthy conditions of these so-called farms. Once individuals were engaged in documenting the conditions, they spread the word of their activity through their own informal networks.

Communication within informal networks moves horizontally and is highly reliable and effective since peers are communicating about their experiences. Over time this physical manifestation of the factory farm began to take hold in the public mind. Because of this geographic grounding, the issue began to push upward. In the meantime, organic farming and organic farm produce outlets began an exponential growth curve, with farmers markets and local entrepreneurs leading the way, culminating in the Whole Foods phenomenon of profitable corporate respectability. The issue was now grounded in hundreds of geographic settings nationwide. Once an issue is embedded in the culture, it has its own life and momentum and needs little advocacy to continue to grow. It just "is."[8] In December of 2010 the congress passed a law that enables the Food and Drug Administration to order recalls of contaminated food items instead of having to rely on the good will of the producers.

In 2009, the documentary *Food, Inc.* came out and had a revolutionary impact on the public because an up-from-the-bottom cultural movement aligned with the scientific facts gathered in the formal systems. The confluence that took place when the informal met the formal is having profound implications.[9] It had this impact because the citizen ecological stewardship base of the movement had become concerned with the issue through their own discoveries, aided by their own ability to network with their neighbors and friends, over their own specific discoveries. The thousands of farmers markets became the main gathering places where empowering information changed hands effortlessly every week. It is this explosion of farmers markets as a national phenomenon that is addressing one part of climate change. This provides a solid base from which to build from the ground-up a "cooling of the globe" movement.

Local language use in a geographic context is critical for citizens to mobilize in their own self-interest. Had the movie *Food Inc.* come out in the manner that Gore's film did, it would have had less impact because the people at the grassroots would not have had their own experiences, their own ownership, in their own language and geography, to connect with the issue.

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[7]"Pollution" is a word that the American people have come to understand as dangerous and damaging to one's health and livability. It is a well-grounded word in almost all geographic language uses, yet it did not find a core use to be built upon by climate change advocates.

[8]The "is" theory was first expounded by Ed Ricketts, owner of the Pacific Biological Laboratory in a discussion about "breaking through." It is documented in the book by John Steinbeck, *The Log from the Sea of Cortez*, "About Ed Ricketts", page xii.

[9]Farmers and activists lean to a truce on animals' confinement, The New York Times, Thursday August 12, 2010.

2.2 The Missing Ingredients for a Social Movement

Climate change advocates have missed this important stage in constructing a social movement. To be successful any movement must eventually come from the "bottom-up" with people identifying and solving their own issues. With the "factory farms" case, there was eventually an aggregation of these thousands of multiple issues that matured into a national demand that the way our beef, pork and eggs are produced had to change. A threshold has been passed and the trend is now solidly towards more natural and local products and away from factory farms. What was discovered is that price was not the real issue, as argued by the factory farms. The real issues were the inhumane treatment of animals and food handling that makes one sick such as the salmonella egg recall in August of 2010.[10] This was aided by the consumers' respect for our small-scale family-centered rural heritage, and by direct association, with growers through farmers markets. Price was only a theme used for political purposes and ultimately it was not tied to citizen interests and was ineffective in blunting this movement.

This bottom-up movement materialized this year in the Food Safety Modernization Act that passed congress and was signed into law December 2010 by President Obama. This bill, fueled by massive grassroots support, is a major overhaul of the food-safety system giving the Food and Drug Administration (FDA) the authority to mandate recalls of tainted food the moment they are discovered. Before this act was passed the recall was voluntary on the producer's part. The bill also has many other provisions concerning food-safety plans, increases inspections of domestic and foreign food facilities, and required record keeping for farms and processors.

The fact of climate change and how it is viewed has to be modified in a thousand ways at the grassroots level in order to create the movement needed to be effective in addressing the warming of our planet. To understand how a grass roots level of action is supported, it is useful to visit a process that has been developed over the last 40 years known as Human Geographic Issue Management Systems (HGIMS). This process has been successfully applied to situations of social change in response to government and corporate change initiatives in numerous settings.[11] Fundamental to the approach is the proposition that the most effective way of fostering the sustainability and

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[10] "Recall expands to more than a billion eggs," Associated Press, August 20, 2010. The Food Safety Modernization Act's passing was aided by the serious outbreaks of E. coli and salmonella poisoning in eggs, peanuts and produce in recent years.

[11] Some examples include: (1) Development of a Social Impact Management System (SIMS) for the City and County of Honolulu, 1979–1983, population approximately 900,000. (2) Human Geographic Issue Management System for natural resource managers in the southern Willamette Valley, Oregon, 2001, population approximately 800,000. (3) A Regional Social Assessment of eastern Washington for the Spokane District of the Bureau of Land Management, 2010, approximate population of 700,000. (4) Building support for the Denver International Airport in Adams County, Colorado through the Discovery Process in a complex permitting environment, 1989. (5) Town of Basalt, Colorado, Governance by Social Capital as operating principle for town government, 2005–09. (6) Washoe County, Nevada, an Issue Management Program, 1990–1991.

livability of communities is to align the beliefs, stories, traditions and practices that make up culture at informal local levels of society with the goals, the science, and the legal framework represented by the formal institutions which serve us.

An Implementation Model for Program and Policy Development Regarding Global Climate Change.

The Human Geographic Issue Management System (HGIMS) is part of a well-developed theory and methodology of applied social change called Social Ecology.[12] Its full conceptual framework will not be outlined here. However, the heart of the system is four principles of Social Ecology:

2.3 Five Principles of Social Ecology

1. Social meanings of local language: As described above, geographic, cultural language is essential to connect with the social meanings of local people on the ground whose behavior is adaptive and already changing to meet the challenges of a warming globe. Capture the language that people are already using to address their self-interest in building and living healthier lives, and it will foster change in behavior as it affects climate change. Language reflects the culture of a geographic area and how people in that culture interpret the world. People are attuned to "pollution" and "fossil fuel independence" and are acting accordingly. When you talk to people in their gathering places you often hear them comparing notes on "more miles per gallon", how the weather seems to be getting warmer or colder, talk about how their gardens are doing and how great it is to eat their own vegetables, who has just bought a Prius – all language uses to build on.
2. Human Geographic Mapping: Human geographic mapping reflects the ways that human populations actually adapt and relate to their landscape. The section below details the rationale and the application of this concept in building a global movement of change in addressing climate issues.
3. The Social Capital of Sustainability: Informal network systems of communication and caretaking form the social capital by which communities sustain themselves.
4. A truism of applied social change programs is that the programs must align with the culture to be effective. Public initiatives designed to mobilize people to participate in solutions must work within these informal systems in order to reach people through their own cultural mechanisms.
5. Emerging Issues: Citizen issues develop from the adaptation of individuals to a changing environment and they represent actionable opportunities for agencies in collaborative relationships. Citizen issues are statements individuals at the grass roots make which are actionable. They predict the sources of social action

[12]Preister K, Kent JA (1997) "Social ecology: a new pathway to watershed restoration." In: Williams JE, Dombeck MP, Wood CA (eds) *Watershed restoration: principles and practices.* The American Fisheries Society, Bethesda.

at the informal level of society. In contrast, management concerns derive from formal institutions. While they are equally legitimate, it is the citizen issues that are often missed because informal systems are usually invisible to advocacy or special interest groups.

2.4 Discovering and Learning Community

The central methodological tool of HGIMS is The Discovery Process.™ The Discovery Process is a qualitative research method to understand an area as local people do by entering the routines of the community and describing it directly, with no preconceived filters, biases or assumptions – what we call a disciplined stranger. It involves using seven Cultural Descriptors to provide a holistic and comprehensive view of community life – settlement patterns, publics, networks, work routines, support services, recreational activities, and geographic features.[13] Description is a critical step and one that is either missed or implemented too late by organizations which are tempted to rely on shortcuts, such as census information or interviews with local elected officials. If change agents do not understand how residents in a community currently function, how individuals maintain their culture, and solve life's challenges, they cannot foster change that makes sense to everyday people. In this case, formal initiatives will be treated as outsider imposition and resisted by citizens, even though authority figures may say the initiative is in their own best interest, a term often associated with colonial control over a population.

To gain this perspective of learning community, a descriptive approach is pursued where the observer participates in daily routines of citizens in their geographic setting, asking naïve questions to elicit stories of place, assessing how communication occurs and who is well regarded among their peers. The cultural mechanisms by which people come together and accomplish projects for the common good, and the current citizen issues with which people are grappling, are identified.

As part of the Discovery Process, human geographic mapping identifies the natural borders within which the various cultural elements of society function, whether it is a neighborhood in Boston or villages in the Sudan. People everywhere develop an attachment to a geographic place, characterized by a set of natural boundaries created by physical, biological, social, cultural and economic systems. This is called a Bio-Social Ecosystem. The term was created in 1991 by James Kent and Dan Baharav to integrate social ecology and biology in addressing

[13] Kent JA, Preister K (1999) "Methods for the development of human geographic boundaries and their uses", in partial completion of cooperative agreement No. 1422-P850-A8-0015 between James Kent associates and the U.S. Department of the Interior, Bureau of Land Management (BLM), Task Order No. 001.

watershed issues with people being a recognized part of the landscape.[14] Unique beliefs, traditions, practices and stories tie people to a specific place, to the land, and to social/kinship networks, the reflection and function of which is called culture.

2.5 The Six Scales of Human Geography

Six different scales of human geography have been discovered, as shown in Fig. 19.1.[15] Operating at the proper scale brings optimum efficiency and productivity to projects, programs, marketing, policy formation and other actions by working within the appropriate social and cultural context. The chart begins with the individual in the center and moves outward from there through various aggregations from the neighborhood level and ending in a global unit.

1. Neighborhood Resource Unit (NRU)
2. Community Resource Unit (CRU)
3. Human Resource Unit (HRU)
4. Social Resource Unit (SRU)
5. Cultural Resource Unit (CuRU)
6. Global Resource Unit (GRU)

Human geographic mapping allows the cultural elements present in each area to be brought to bear to foster action on the ground. It allows, first of all, recognition that there will be regional differences in the policies and programs designed to

[14]Kent JA (1991) "Eco-Mapping: planning and management of bio-social ecosystems." Thorn Ecological Institute (with Dan Baharav), Boulder. The first Human Geographic Maps (HGMs) came into existence in the late 1970s and early 1980s as part of JKA's work with the US Forest Service, Region 2, Forest Planning process. The USFS was looking for new and creative ways to assist citizens to empower themselves in using forest planning to ensure the health of the lands and their communities. The HGMs were published as an integral part of the Forest Plan implementation. This was followed in 1986 by a contract with the US West (now Quest) Corporation to map the 14 states that made up their service area in order to launch their cell phone business based on cultural word-of-mouth and natural boundary systems. In 1995, the Bureau of Land Management (BLM) signed a 30-year license agreement for the use of human geographic maps for planning and management purposes. Subsequently the HGMs have been used by communities, businesses, corporations, governments and citizens to improve relationships, make trend projections, develop market segments, and to understand emerging patterns in order to improve the way government and business is conducted.

[15]Quinkert AK, Kent JA, Taylor DC (1986) "The technical basis for delineation of human geographic units", Project working paper for USDA/SBIR Project Grant #85-SBIR-8 – 0069. Available at: http://www.naturalborders.com/Docs/Technical-Basis-for-Delineation-of-Human-Geographic.pdf. This research, supported by the National Science Foundation, sought to find quantitative counterparts such as zip codes or phone calling areas, to the qualitative Cultural Descriptors outlined in this paper but strong correlates were not found. Hence, shortcuts are unlikely, requiring policy makers to employ a descriptive approach in understanding the cultural lifeways of people affected by their policies.

ameliorate global climate change. The heavily forested regions of the Pacific Northwest will contribute in different ways to climate change initiatives than the deserts of the Sahara, the jungles of Borneo, or the outback of Australia. However, this point applies to the very local level as well. That is, successful climate change policies depend on having healthy action at the individual, neighborhood, and community scales on up to the global scale. Action is thus aggregated from local to global, all anchored to appropriate cultural approaches at each scale.

Second, because the maps represent the ways in which people actually relate with and use their landscape, any initiatives that match the boundaries will be more effective than initiatives that are laid over the landscape according to political jurisdictions. Change programs that "match the culture" are incorporated into everyday routines of people in their communities and they are effective. Programs which do not grow from the culture are interpreted locally as being imposed from the outside and are resisted by citizens regardless of their scientific merit. This is the trap of imposed rational thinking.

A cultural approach in developing policies and programs intended to address global warming permits decision-makers to avoid the dangers of a strictly regulatory approach. It is not that regulation will not be part of the response to global warming but it should not be the first policy choice, nor is it applied universally but is targeted by geographic area according to local conditions. When the State of Oregon salmon recovery plan was developed in the 1990s, it explicitly recognized the fiscal and political limits of regulation. Then-Governor Kitzhaber made public statements that if Oregon residents did not voluntarily want to restore salmon habitat to enhance salmon's numbers, no amount of regulation would accomplish the objective. Rather, it is the behavior of individuals, families, and institutions that change voluntarily because they are aware of the issues and they want better conditions for their environment and their community. Policies have to recognize cultural elements and create incentives for people to change behaviors at the local level. In the following pages, we will show how citizen action is maintained at each scale of human geography, pointing to the way that climate change policies in the future can be effectively implemented.

2.5.1 The Application of Human Geography to Climate Change

The individual at the center of the bull's eye in Fig. 19.1 is the main adaptive unit of society. The individual acts in an empowered way, that is, desires to participate in, predict and control his or her environment in a manner that does not exploit others.[16] It is at this level where people make commitments to create a livable and healthy environment that includes the use of alternative energy, gardens, Growing Domes

[16]Preister K, Kent JA (1984) "Clinical sociological perspectives on social impacts: from assessment to management". Clin Sociol Rev 2:120–132, p. 125.

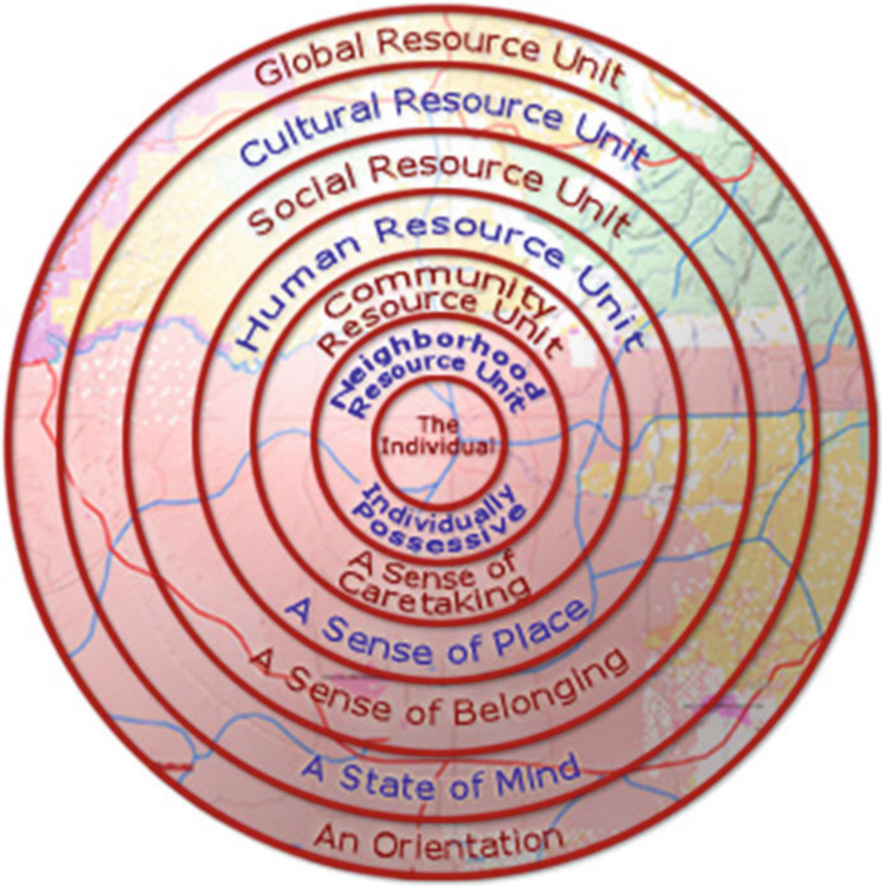

Fig. 19.1 Six scales of human geography (Source: ©2011 James Kent Associates)

(geodesic domes within which to grow food),[17] creating pedestrian-centered communities, insulating homes and retrofitting them to reduce dependence on fossil fuels.

To the degree that the smaller circle is healthy and creative is the degree that aggregation will work at the next level, that is, action can move outward to the Neighborhood Resource Unit where caretaking of each other and sharing through informal networks take place. This phenomenon is both measurable and a way to direct social action. The next level is the Community Resource Unit, which is an aggregation of the action at the neighborhood levels. Action at this scale creates project level self-sufficiency

[17] One of the main reasons Puja Dhyan Parsons and her husband Udgar Parsons started Growing Domes™ 20 years ago was to support others who want to live sustainable, healthy lives. The company's innovative growing domes demonstrate a solar self-sufficiency that keeps fresh food on the table, even within the challenge of environmental and economic changes. In 1995, the company relocated to Pagosa Springs, Colorado where they remain today. In 2010 they won the Colorado Business Award as one of the top 50 companies to watch.

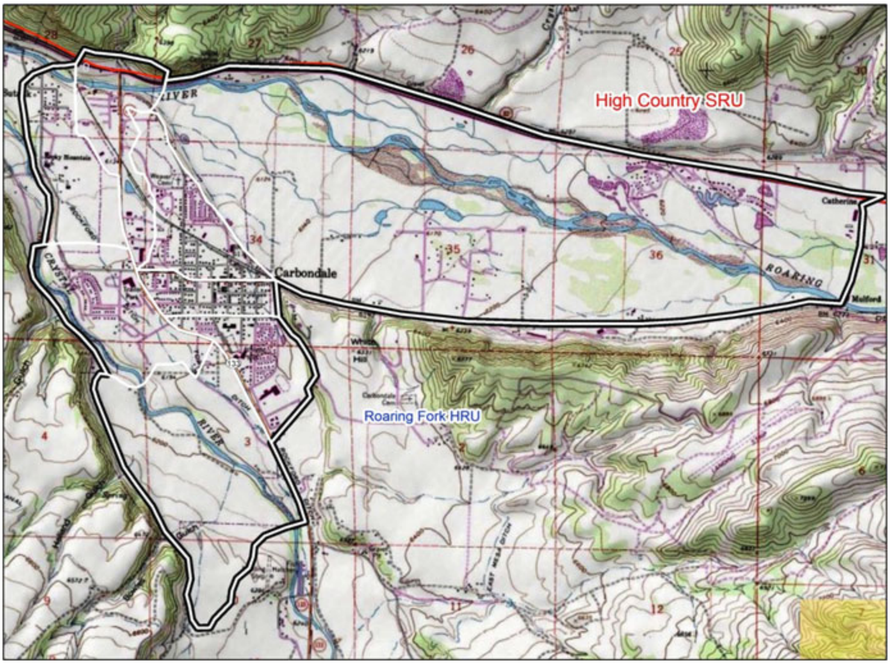

Fig. 19.2 Neighborhood Resource Units (NRUs) within the Carbondale Community Resource Unit (CRU)[18]

programs that benefit the whole community and builds towards a “tipping point” that a cultural shift from fossil fuels to alternative energy is taking place. Community Units aggregate to the Human Resource Units which are larger cultural zones including several communities. At the Social Resource Unit level are the several Human Resource Units that make up the sense of belonging at this larger scale of interaction. From aggregation of the Social Resource Units is created the regional Cultural Resource Unit and from there is created the Global Resource Unit.

To illustrate the above discussion, we will use the community of Carbondale, Colorado to show how healthy activity at each scale of human geography generates “grounded” action at higher scales.

2.6 The Neighborhood Resource Units of Carbondale, Colorado

Figure 19.2 shows the Neighborhood Resource Units (NRUs, shown in white) in the Community Resource Unit of Carbondale, Colorado. At the neighborhood level, the use of composting, growing organic gardens, xeriscape lawns and individual solar

[18]Human geographic maps provided by Monteverde Associates, Portland, Oregon, tavomonte@gmail.com

collectors is evident. Over the past 3 years, 8–12 dozen buildings in Carbondale have installed photovoltaic (PV) or Solar Thermal collectors. This has been facilitated by State Amendment 37, which requires investor-owned utilities to produce 10% of their electricity from renewable sources by the year 2015.[19] Utility and local rebates and tax credits have considerably reduced the retail cost of purchase and installation. Small businesses are emerging to meet this demand. There are many early adapters among the citizens who began their "energy independence" journey during the Carter Administration and they have flourished and assisted their neighbors in adapting to being more self-sufficient in becoming free of oil dependence.

2.7 Community Resource Units of Carbondale, Colorado

The Carbondale CRU (black lines in Fig. 19.2 above) is an aggregation of the NRUs. It is at this level that a confluence of energy takes place where neighborhood efforts are optimized to the broader community. Carbondale is known for a number of citizen and town government actions related to climate change and sustainable ecology. Many of the informal leaders in the social, economic and cultural conversion of Carbondale to reduced fossil fuel dependence got their start with the renewable energy programs of the President Carter administration in the 1970s. This has created an intergenerational absorption process where from these early starts a full-blown cultural phenomenon addressing the warming of the globe has taken place over the last 40 years.

The following are several of the actions that have been and are taking place:

- Third Street Center: Two members of the Board of Trustees for the Town of Carbondale initiated community discussions to brainstorm about the idea of converting a soon to be abandoned elementary school into a non-profit/arts center. Community members supported the idea and the Board of Trustees over 2 years negotiated a land trade with the school district to secure the elementary school building. Once the building was secured, a local team of citizens produced a strategy for redeveloping the school into a sustainable home for local non-profits and artists. The town contributed $150,000, and the citizen team secured $1.7 million from public and private entities. With a local bank participating that acted in the community's interest, the stage was set for the development team to transform the elementary school into the Third Street Center, which has energy efficiency improvements throughout the building, including the use of natural light, a variety of efficiency measures in mechanical and utility systems, and a 50kw photo-voltaic (PV) array on the roof of the structure. Currently, it is home to a variety of non-profits, including energy and environmental groups, artists and human service organizations.

[19] Broehl J (ed) (2004) "This is the first time in the Nation's history that a renewable energy portfolio standard was put directly before the voters rather than processed through a state legislature." Renewable Energy.com, November 3, 2004, "Colorado Voters Pass Renewable Energy Standard."

- Power Purchase Agreements (PPA's) have allowed third parties to invest in PV arrays – a 50kw system on Town of Carbondale Recreation Center building and a 150 kw array on property owned by the Colorado Rocky Mountain School, an internationally-known private school with a community focus for its curriculum. At the time of completion, this was the largest array in Western Colorado and at the opening ceremonies several state and national political figures, including the Governor, Senators and House of Representative members spoke and praised the effort.
- A budding grassroots effort of local activists, called Carbondale Economic Localization (CEL), are endeavoring to identify measures that can be taken to re-localize the Carbondale economy in the face of "Peak Oil" and the end of the cheap energy economy.
- Grassroots efforts are promoting organic gardening throughout the community. Residents developed a plan to create 200 garden plots on town-owned land. The existing community garden plots are so popular that it is said that someone has to die in order for a new person to get a plot. The citizens are expanding the plots for next year. A local restaurant, called "689" was one of the first in the nation to grow their own vegetables and other edibles that were incorporated into the seasonally- based menu. This restaurant is ranked in the top 100 in the nation.
- A grassroots group is centered on organic food, teaching life skills and building community. This budding group is raising funds to build an outdoor, community accessible, wood-fired bread oven at the Third Street Center in 2011. The idea is to have people learn to bake for themselves once again.
- The Carbondale Energy and Climate Protection Plan, available for review on the town's website (www.carbondale.com), sets aggressive goals for the direction of the community. This is only possible to succeed because of the absorption and adaption to healthier lives at the Neighborhood Resource Unit level.

It is clear that citizens at this level are empowered and see the next steps they need to take to improve their situation. Absent from local language is talk of global climate change. Instead the language of change is focused on taking care of their kids, making their community energy independent, the warming of Carbondale, changes in weather patterns that affect skiing and the Carbondale economy, and taking care of the senior people.

2.8 Human Resource Unit of the Roaring Fork

The Carbondale CRU is part of the *Roaring Fork Human Resource Unit* (HRU, Fig. 19.3), which also includes the communities of Aspen, Snowmass, Old Snowmass, Basalt, El Jebel, Aspen Glen, and Glenwood Springs. Throughout the Roaring Fork HRU are renewable energy projects, some dating back to the 1970s such as the Rudi Dam that is a recreation and sports lake but also supplies electrical power to the city

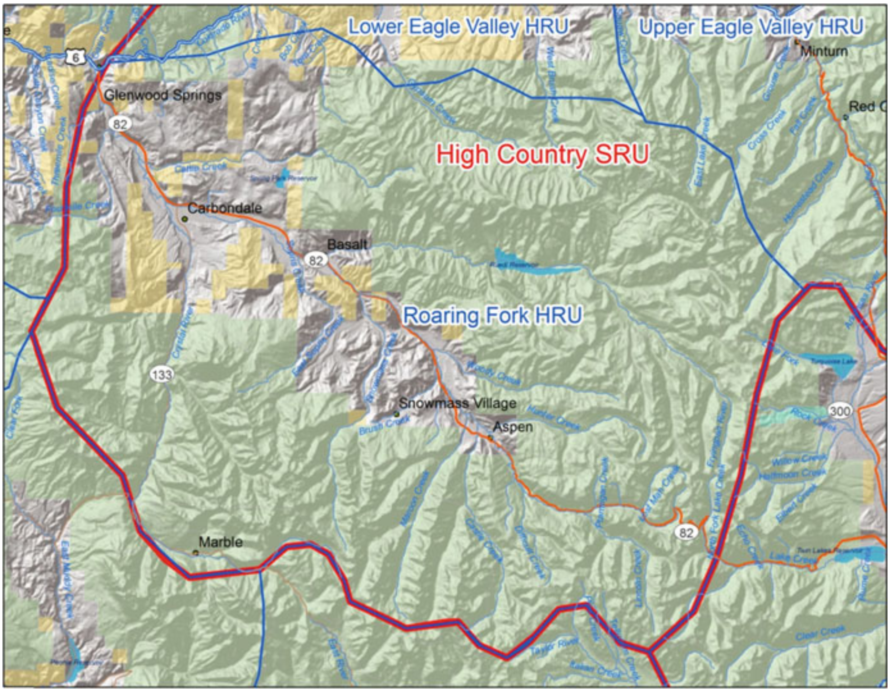

Fig. 19.3 The Roaring Fork Human Resource Unit (HRU)

of Aspen. The Basalt community completed in 2010 an $11 million regional library that is state of the art and is 100% off of the grid. Farmers markets and community gardens are present in every community of the HRU. A Whole Foods store is considering its first smaller 20,000 square foot store, nationally, in mid-valley at El Jebel because of the people's commitment to healthy eating habits.

The Aspen Skiing Company is located in this HRU and has been a leader in renewable practices within the company and community. The Aspen Ski Company created a Vice President for Sustainability and is a leader in the fight for slowing down the warming of the globe that is part of their stated company objectives created in 2002. According to Auden Schindler the VP for Sustainability, if you do not have snow, there is no ski industry. This global commitment is the first of its kind among international ski corporations.

A Carbondale-area group of designers, planners, architects came together with a vision to create examples of carbon neutral development and redevelopment. Calling itself the Sustainable Center of the Rockies (SCOR), the group originally put a five-acre property under contract to build a model building/facility/campus. They held a community charrette to gather input on how to proceed and what type of facility the community wanted to build. The community responded with a variety of ideas about what a facility like this could be. However, the most important input to SCOR from the community was that it would be more sustainable to adaptively reuse an existing

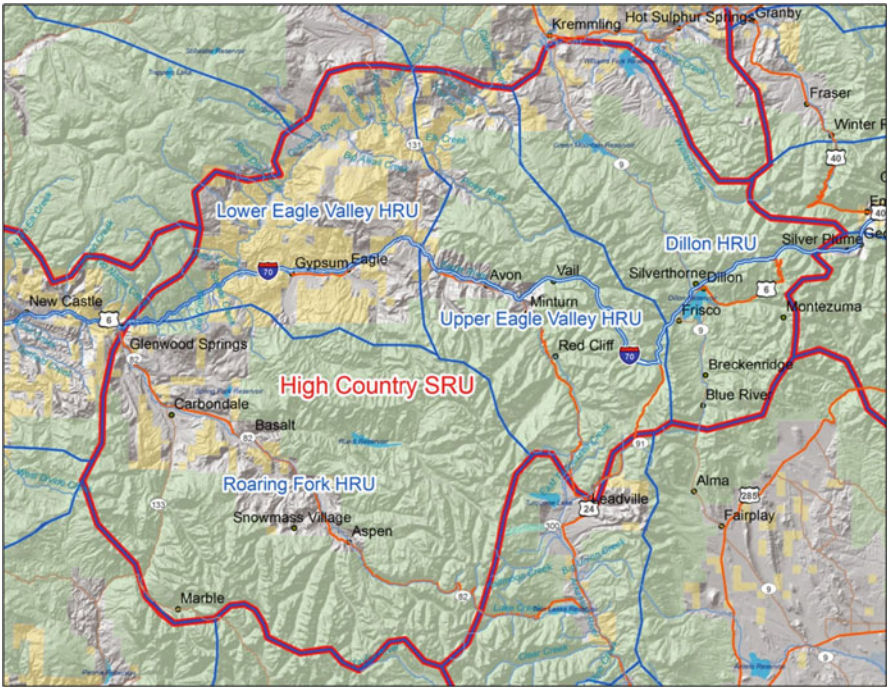

Fig. 19.4 The High Country Social Resource Unit (SRU)

building rather than undertake “greenfield” development. Additionally, if SCOR could create a sustainable building, which currently existed, then that would provide valuable knowledge for the entire man-built environment. SCOR was instrumental in conceptualizing the Third Street Center design and now provides consultation to groups and governments throughout the HRU, the State and Rocky Mountain region.

Renewable concepts and practices have become intergenerational with stories of how the families got going with renewable processes and how those were handed onto their kids and now grand kids. The people of this Roaring Fork HRU are full participants in alternative energy to free our nation’s dependence on fossil fuel.

2.9 Social Resource Unit: The High Country

The High Country SRU (Fig. 19.4) contains the major winter recreation sites in Colorado. It includes Dillon, Frisco, Breckenridge, Vail, Beaver Creek, Minturn, Eagle, Gypsum and Glenwood Springs. It includes four HRUs: Dillon, Upper Eagle Valley, Lower Eagle Valley and Roaring Fork.

There are several major ski areas in this SRU including Loveland, Copper Mountain, Vail, Beaver Creek and Aspen. Following Aspen Ski Company's leadership, the other ski areas are joining the effort to address climate change on the national and global level. In addition, the U.S. National Forests are major players at this SRU level since skiing and other recreational activities depend on formal permits and informal collaborative agreements on using forest resources to create a sustainable future. Extraction of resources is no longer the dominant focus, having been replaced by uses that lead to renewability. The people in this area are very outdoors oriented and they are invested in environmental quality, in part because their livelihood stems from quality of visitor experiences. A number of energy and environmental groups that began as citizen movements formed organizations and are now providing expertise throughout the SRU. The citizens developed the ideas and local governmental units facilitated with funding. These include:

- CLEER (Clean Energy Economy for the Region) works to accelerate the transition to a clean energy economy, increase energy independence and reduce impacts of climate change. CLEER was started by a group of concerned citizens who have worked to help governmental entities implement transportation, energy efficiency and renewable energy strategies in the region. CLEER continues to be a citizen-based group and while some elected officials sit on the Board of Directors, there is no formal tie to any government.
- G-NECI (Garfield New Energy Communities Initiative) was started by CLEER and is now a formal part of the region's government. G-NECI was formed through a 9-party Intergovernmental Agreement (IGA). The IGA is comprised of Garfield County and the municipalities in Garfield County, Roaring Fork Transit Agency and Library District. G-NECI has raised funds through local governments and the state and is now implementing a county wide energy efficiency/renewable energy strategy. G-NECI's Board of Directors is comprised of representatives from all the participating entities. CLEER is under contract to manage G-NECI's projects.
- CORE (Community Office for Resource Efficiency) has been in existence for over 15 years and is funded by the city of Aspen, the town of Snowmass Village, Pitkin County and Holy Cross Electric (a locally consumer owned electrical cooperative). The bulk of CORE's funding comes from Aspen and Pitkin County exactions for energy impacts from new construction. CORE funds a variety of energy efficiency and renewable energy projects in the valley. CORE's Board of Directors is made-up of representatives from its sponsor group.

The activities in this SRU can be seen to be occurring in other SRUs throughout the U.S. West.

2.10 Cultural Resource Unit: The Northern Rockies

The High Country SRU is embedded in the Northern Rockies Cultural Resource Unit (CuRU, Fig. 19.5), which includes Colorado. The National Energy Laboratory

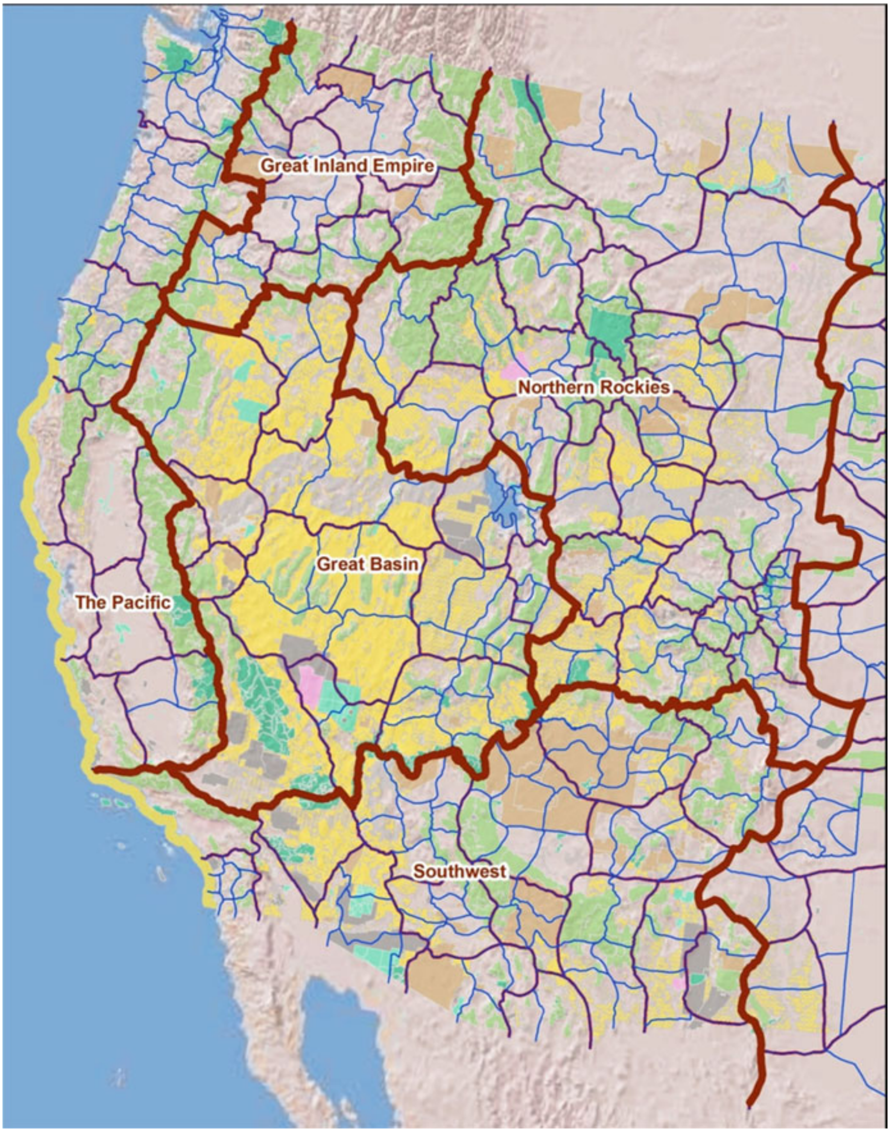

Fig. 19.5 Cultural Resource Units of the Western United States

set up in Colorado 30 years ago had a major influence on developing professionals and intellectual capital for renewable energy development. This energy lab set the stage for attracting renewable energy companies to the Northern Rockies CuRU. Because of the action in different SRUs and the favorable climate for renewable energy, manufacturers of wind machines have begun to set up in Colorado. Recently the United States headquarters of the international company, Abengoa Solar, founded in Spain in 1941, has been established in Lakewood, Colorado. This company is planning solar projects throughout the U.S. Southwest.

The State of Colorado through a citizen referendum passed Initiative 37, which stipulates that 10% of its energy must be from renewable sources by the year 2015. A confluence occurred as a result of this legislation. Because there has been a bottom-up building of a culture for sustainability there was widespread support for this action. As a result Xcel Energy made the first major move as a regional energy company to convert from coal generation to natural gas. This has sent shock waves throughout the coal industry, as this is the first conversion to cleaner fuels announced by an energy provider in the Northern Rockies CuRU. Xcel also has projects with Abengoa Solar for other projects that will reduce dependence on fossil fuels in this CuRU. That point should not be missed that changes at this level have been made possible because of the actions taken since the 1970s by people at the neighborhood, community and regional levels.

Other activities at the cultural unit level that are getting traction are Bark Beetle coalitions formed to deal with millions of acres of standing dead Lodge pole Pine. Incubated in Breckenridge, Colorado collaborative efforts to address this ecological disturbance that has affected the entire cultural unit are now wide spread. Senator Mark Udall has passed legislation to provide funds to the U.S. Forest Service, Region 2, for treatment in areas affected by the bark beetle infestation.

In Aspen, a citizens group called For the Forest, has organized a collaboration between private land owners and the U.S. Forest Service to clear beetle kill pines from Smuggler Mountain, a specially-protected area in the Roaring Fork HRU. This citizen-initiated effort did not wait for the federal government to develop this program. An ex-mayor of Aspen who was a leader in the 1990s in renewable energy started it. The program is in its very successful second cutting using helicopter technology to "be light on the land."

Two ex-US Forest Service professionals working as consultants for the Salvation Army in Haiti, contracted with a Montrose, Colorado wood mill to produce lumber and pre-fabricated units from the standing dead beetle kill pine. They have used this standing dead timber to build over 600 emergency shelters in Haiti after the earthquake, with plans to build 4,000 more.

Finally, the Governor's Energy Office recruited one of Carbondale's community and energy activists to spear head state wide renewable energy projects. This person worked for CORE in the Carbondale office and was responsible for many of Carbondale's local initiatives. She now travels around the west slope of Colorado assisting communities in the energy arena. She represents a vital link to the Governor's office and can maintain two-way communication across the six human geographic scales.

The high level of National Forest and Bureau of Land Management land ownership contributes to the renewability surge in this cultural unit. It is interesting to note that throughout the cultural unit are a high number of Prius automobiles. It is claimed that there are more Prius cars owned, per capita, in this CRU than anywhere else in the U.S.

Fig. 19.6 The Pacific Rim Global Resource Unit

2.11 Global Resource Unit: The Pacific Rim

Figure 19.6 shows the aggregation of different human geographic units into a Global Resource Unit (GRU) called the Pacific Rim. At the global level, it is clear that new job creation in renewable energy, especially for manufacturing in areas such as windmills and solar cells, presently is shared between China and the U.S. side of the Pacific Rim GRU. Our side of the Pacific Rim needs to create more capacity for renewable energy manufacturing. Manufacturing of wind blades and towers needs to be developed close to the geographic place where they will be used. While technology can be shared across boundaries, local and regional capacity needs to be created for social, cultural and economic ecological reasons. For example, a successful electric motorcycle manufacturer, located in Ashland, Oregon, has spent years developing the technology and getting the necessary patents. Now that it is ready to go to production, lack of local production capacity has forced them to sign a contract with an electronics manufacturer in Singapore.[20]

There is much effort to be expended to make this GRU work for its North and South American components.

[20] "Brammo's bikes go global," *Medford Mail Tribune*, September 23, 2010.

2.12 Enter Citizen Based Ecological Stewardship

In summary, knowledge at a local level – of the lifestyle routines, the cultural practices, and the innovations – can be incorporated into an implementation model to foster behavioral changes needed to address climate change. Human geographic mapping, especially, offers a powerful way to conceptualize and mobilize for the necessary changes.

At the neighborhood and community level, individual and family change can be observed, identified and supported. For climate change projects, the Human Resource Unit is the appropriate human geographic scale at which to work, to avoid surprise, incorporate local knowledge, and build support. Knowledge of social trends at the HRU level allows projects to respond to them in order to optimize local social and economic benefits of projects. At the Social Resource Unit level, the maturing of organizational capacity and the incorporation of renewable paradigms will pay great dividends. At the SRU, CuRU, and GRU levels, manufacturing capacity, away from industrial applications and toward renewable applications, can be encouraged through actions such as Colorado Amendment 37 which establishes a time frame for renewable energy targets.

A human geographic issue management system (HGIMS) is a management process in which citizen issues are incorporated with management concerns to produce integrated action with shared responsibility for implementation. Actions are thus derived from both informal and formal systems, creating "cultural alignment." When cultural alignment is achieved, programs and policies can be implemented with full citizen support and participation, lowering costs and improving effectiveness. The resilience of both systems is enhanced.

Policy-makers must be careful to avoid assumptions about how new initiatives will be received. Energy companies routinely promote wind energy as "clean energy," believing for that reason that wind energy projects will be supported. Despite the national rhetoric about the value of wind energy projects, citizens at the project level throughout the country are resisting them. For project proponents to revert to slogans such as, "It's that NIMBY-ism (Not in My Back Yard) rearing its ugly heard again" or "People are just apathetic and don't care" misses the point. These projects are failing because citizen issues are not understood and incorporated into project planning.[21]

Scratch below the surface of any geographic area in which humans live and you will find stories of place, of people attached to the land, to their place-based community and to kinship. Whether this rootedness is of indigenous people who have lived in a place for thousands of years or whether it is a new retirement community in the U.S., people adopt local place names, they learn the stories of the place and they learn about what it means to be part of their ecological setting.

[21] Kent JA, Preister K, Malone T, Wood D (2009) "Wind energy development and public perception," Right of Way Magazine, International Right of Way Association, May–June, 2009, pp 32–35.

Citizen-based stewardship is pervasive and prevalent throughout human society, reinforced in daily social practices. Even in highly degraded areas, individual and group efforts to take care of their land and ocean resources, as well as their communities and each other, can be observed and documented. When implementation models account for this powerful force, tremendous energy for change will be unleashed, creating a true partnership to “Cool the Globe.” It is the language of everyday people, the language of hope and survival that must become the basis for cooling the globe.

Chapter 20
Tomales Bay Watershed Council: Model of Collective Action

Mairi Pileggi, Robert Carson, and Neysa King

Abstract The Tomales Bay Watershed Council, whose 24 members represent community and environmental groups, agricultural, maricultural and recreational interests as well as public agencies, provides an example of a successful collaborative approach to watershed stewardship. The Council formed in 2000 to develop a comprehensive watershed management and stewardship plan for the Tomales Bay watershed, a 220 square mile area in Marin County, California. The Council mandated a consensus decision-making process to insure that all constituents were heard. Of primary concern were problems related to water quality in the bay and tributary streams. This chapter focuses on the actions the Council adopted to address these problems. Specifically, it chronicles the implementation of a water quality monitoring plan and practices to reduce nonpoint sources of water pollution in the watershed within a consensus framework.

Keywords Consensus decision-making • Water quality • Watershed council

1 Introduction

Implementation of the National Environmental Policy Act (NEPA) opened possibilities for citizen participation in federal environmental policy decisions. NEPA recognized that "citizens often have valuable information about places and resources that they value and the potential environmental, social, and economic

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effects that proposed federal actions may have on those places and resources." (A Citizen's Guide to the NEPA). The Clean Water Act of 1972 and the Endangered Species Act (1973) alerted citizens to the need for local oversight and involvement in watershed management. Recognizing the importance of stakeholder participation to meet national goals for water quality and to insure the survival of sensitive species, local resource management groups formed. By the mid-1990s, watershed groups were active across the nation, and citizens recognized them as an important mechanism for decision-making at an ecosystem level as, crossing jurisdictional and political lines, they brought together land managers, regulators and community stakeholders.

While some government and community groups have moved toward more collaborative decision-making methods, other stakeholder groups have taken this a step farther by adopting a consensus process to conduct business and reach decisions. Using a consensus process, they argue, promotes equality among stakeholders through a structure that allows multiple perspectives to be voiced. Doing so creates a shared sense of purpose, helps stakeholders learn more about each other, facilitates the exploration of better solutions to problems and may foster stronger community bonds. However, some researchers and practitioners argue that consensus is slow and that often work doesn't get done. In certain cases, especially where stakeholders are polarized, consensus will not work (see Reed 2008; Voinov and Gaddis 2008; Connelly and Richardson 2004).

This chapter looks at the Tomales Bay Watershed Council, whose 30 members represent community and environmental groups, agricultural, maricultural and recreational interests as well as public agencies. The Council formed in 2000 to develop a comprehensive watershed management and stewardship plan for the Tomales Bay watershed, a 220 square mile area in Marin County, California. Using the Council as a case study, we examine the successes of a collaborative approach to watershed stewardship and highlight some of the problems stakeholders face when success is not forthcoming. Recognizing the strengths and challenges of collaborative decision-making will help other communities, and especially their watershed councils, understand water quality problems, find constructive ways to create strategies that protect open space and species habitat, develop sustainable land-use practices and reach mutually beneficial decisions on how to manage or implement them (Stewardship plan, p. 17).

2 Tomales Bay: A Brief Cultural History

For centuries, Coast Miwok Indians inhabited the lands of the Tomales Bay watershed. They lived in apparent harmony, sustained by abundant shellfish, fowl and fish in the bay and game and acorns from dense oak forests that covered the hills. By the early 1800s, European settlers had forced the Miwoks off their lands and into missions. With the gold rush in 1849, San Francisco's population exploded from 800 to 50,000 (Avery, p. 32). Agriculture boosters heavily promoted the area to attract farmers who would supply food for these new immigrants. As Avery notes, the number of Californians working in agriculture grew from 2,000 in 1850 to 47,983 in 1870 (p. 32). With its proximity to the city, agriculture near Tomales Bay, principally dairy and potato farming and beef cattle ranching, became profitable. Since overland routes to San Francisco were difficult, Tomales Bay and its tributaries gave growers the means to transport their products by boat. Unfortunately, poor farming practices caused severe soil erosion, and by the end of the century so much silt had washed into Tomales Bay that large vessels could no longer navigate its waters.

As agriculture grew so did commerce to support it. To keep these interests economically viable alternate routes to market were necessary. The railroad, completed in 1874, kept farmers in business and stimulated commercial fishing interests established earlier by Chinese immigrants. The railroad also brought tourists to Tomales Bay. Fishermen and hunters, some of whom stayed at the Bear Valley Country Club, were early visitors. Others soon followed to hike the hills and swim in or sail on the bay.

By the turn of the century, railroad literature and Inverness real-estate developer Julia Shafter's brochures promoted Inverness, a new subdivision on Tomales Bay as an idyllic summer resort (Mason 1974). Completion, in 1930, of Sir Francis Drake Boulevard, the primary route to Tomales Bay, and the opening of the Golden Gate Bridge 7 years later paved the way for tourists. The bay became a summer retreat for Bay Area families and especially educators from Berkeley. Now that Tomales Bay was an established recreational haven, real-estate entrepreneurs, with the support of local business and county government, planned ways to develop the area. However, some Marin residents, in particular Caroline Livermore and members of the Marin Art and Garden Club, were concerned about the effect an increase in tourism and development would have on the environment. In 1934, they formed the Marin Conservation League (MCL) whose "mission to preserve, protect, and enhance the natural assets of Marin County for the public" continues today (MCL website). MCL was instrumental in creating state parks in the watershed including Samuel P. Taylor and, through its effort to preserve coastal areas on Tomales Bay such as Shell and Indian Beaches, Tomales Bay State Park. By the 1960s, as environmental awareness grew in California and throughout the United States, many groups, MCL among them, worked to preserve lands on the Point Reyes peninsula which are now part of the National Park Service's Point Reyes National Seashore and the Golden Gate National Recreation Area.

2.1 A Legacy of Conflict

Since perhaps the earliest encounters between Coast Miwoks and settlers, conflict has been a constant in the history of Tomales Bay and its watershed. Competition among farming, fishing, recreational, or environmental interests and differing perspectives on how the watershed should be used often clashed. In 1894, for example, a disagreement between farmers and fishermen prompted the State Board of Fish

Commissioners to remove a dam erected by farmers on Lagunitas Creek, a major tributary, to allow salmon migration. Conflicts between oyster growers and local fishermen erupted when Eli Gordon's Pacific Coast Oyster Company, established in 1907, fenced in their beds. (Avery, p. 79)

Discord surfaced in the early 1940s when MCL backed a county recreation plan calling for the preservation of "the western shoreline of the bay north from Inverness to Tomales Point" (Avery, p. 126). Ranchers and developers, fearing loss of revenue, lobbied and successfully defeated the plan. By the late 1960s tension between environmentalists and developers and local businesses escalated when county supervisors adopted the West Marin General plan, which envisioned a four-lane highway to Tomales Bay, housing for 150,000 residents and commercial centers along the bay. Dr. Martin Griffin, co-founder of Audubon Canyon Ranch (ACR) bought land tracts (432 acres through ACR) along the Tomales Bay and with MCL and other concerned citizens lobbied the supervisors, who, in 1971, withdrew their support.

In the 1960s, conflict erupted around Chicken Ranch Beach, a popular community beach on Tomales Bay in Inverness. Larry Marks purchased the beach property and land in the adjacent lower Third Valley Creek watershed with plans to develop a private marina. Local activists formed the Inverness Waterfront Committee and filed suit against Marks claiming the public had the right to access the shore. Peter Whitney, Marks' neighbor, also filed suit against him to prevent Marks from filling in and destroying the wetland and to allow public access to the bay. In 1971, the California Supreme Court, ruling in Whitney's favor, decreed "tidelands sold by the state after 1868 are protected for public use and wildlife under the Doctrine of Public Trust" (Griffin, p. 134).

In an attempt to curtail encroaching development and preserve the county's farm culture, county supervisors, in 1972, "adopted 'A-60' zoning, which limited development to one home on every 60 acres in part of West Marin" (Avery, p. 142). Some ranchers were vehemently opposed to the ordinance. The concern was not for agricultural reasons, but because they felt restrictions on how farms could be subdivided would mean a significant financial loss when they stopped farming and sold their land to developers. Others, concerned about urban pressures, took a different approach and in 1980 formed the Marin Agricultural Land Trust (MALT), which granted conservation easements to ranchers. Today MALT "has permanently preserved over 44,100 acres of farmland" (MALT website).[1]

[1] Preservation of land around Tomales Bay and in West Marin was possible because people were actively committed to the environment. That these people had social and political connections as well as financial means made the initial efforts to curb urban development possible (see Griffin 1998). Ongoing efforts, including education, advocacy and land acquisition from groups such as EAC, ACR and MALT were also crucial. However, land ownership by various governmental organizations – the NPS, GGNRC, State Parks, County Parks and Open Space – was the major force in keeping significant areas of West Marin undeveloped. For another example of land conservation and preservation strategies in places adjacent to urban centers, see the Dreaming New Mexico project at http://www.dreamingnewmexico.org/

The National Park Service (NPS), which oversees the Point Reyes National Seashore and The Golden Gate National Recreation Area, about 70,000 acres, is the largest landholder in West Marin. Perhaps one of the most contentious relationships in West Marin is between the Point Reyes National Seashore and certain economically driven special interest groups. One concern of those in conflict with the NPS is a fear of increased government control, which may stem from a belief that the individual has the right to determine what happens on his or her property. This fear may be exacerbated by how some stakeholders understand and interpret actions, which are circumscribed by legal mandate, of government agencies. Loss of tax revenue is another concern, especially for Marin County and California State government.

3 The Tomales Bay Watershed

The Tomales Bay watershed encompasses many smaller sub-watersheds. Bordered to the south by Mount Tamalpais and the Bolinas Ridge, to the west by the Inverness Ridge, and to the east by the edge of the Laguna Lake watershed, it spans approximately 220 square miles, an area nearly 20 times larger than the bay itself. Tomales Bay and its primary tributaries, Lagunitas, Olema and Walker Creeks, comprise a critical network of aquatic, riparian, estuarine and marine ecosystems that harbor a diverse and unique variety of native and indigenous communities. This watershed is sanctuary to Coho salmon and Steelhead trout, along with many other fish species, California red-legged frogs, nearly 500 bird species, and hundreds of invertebrates and plants. Lagunitas Creek supports one of the last viable populations of Coho salmon in California.

As the Council's Stewardship Plan notes, "Tomales Bay is part of the Central California Coastal Biosphere Reserve, … qualifies for inclusion as a wetland of regional importance under the Western Hemisphere Shorebird Reserve Network…and is a 'Wetland of International Importance'" as designated by the Ramsar Convention (p. 21). It is also part of the Gulf of the Farallones National Marine Sanctuary. However, during the last century, human activities have degraded water quality and the habitat that fish and other native communities need to survive. As a result of excessive quantities of sediment, mercury, nutrients and pathogens in surface and bay waters, the Regional Water Quality Control Board, following Clean Water Act criteria, listed Tomales Bay and its primary tributaries as "water quality impaired."

4 Formation of the Tomales Bay Watershed Council

In 1998, more than 170 people became ill after eating Tomales Bay oysters contaminated by the Norwalk Virus. Officials could not determine the source of the virus, which is often carried by human waste. Member agencies of the Tomales Bay Shellfish Technical Advisory Committee, mandated earlier by state law and overseen by the Regional Water Quality Control Board, "identified septic tank failures as a possible source. This incident added to the existing controversy between dairy owners and oyster growers, since wet weather runoff from dairies raised coliform counts" which resulted in oyster closures (Seraydarian 2010). Community members were strongly polarized; some proposed legal action, others sought more constructive and collaborative ways to address community concerns around water quality. In response, several members of the Tomales Bay Advisory Committee convened a group of concerned local stakeholders and enlisted Harry Seraydarian of the U. S. Environmental Protection Agency to facilitate and mediate discussions. Seraydarian interviewed over 30 people to determine what they saw as problems or issues, what they perceived as barriers or opportunities, what they proposed as ways to resolve problems and what they defined as interests. From these interviews he identified "potential common interests" and a "framework" for action. This material was used in discussion about the Council charter and its stewardship plan.

4.1 Consensus Based Approach to Decision-Making

The interviews Seraydarian conducted suggested the need and desire for a collaborative problem-solving approach. Thus, when the Council formally convened in January 2000, they adopted a consensus approach to decision making.

The Council defined consensus as "a process whereby every decision must be approved by all participating persons, and every person maintains the power to veto the final decision of the group." (Tomales Bay Watershed Stewardship Plan, p.126). To help members understand the consensus process, the Council also adopted guidelines, which outlined conduct in meetings. Members should "focus on the issues, not personalities; listen without interrupting; respect other views; be constructive and solution-based; (they were reminded that) everyone contributes, no one dominates: use a consensus approach" (Operating Procedures of the TBWC, p.6). Furthermore, if a member decided to reject a proposal, he or she was also required to suggest a reasonable alternative for the group to consider. As a condition of membership on the Council, stakeholders agreed to abide by these principles. Perhaps most important, although not explicitly articulated, was the understanding that stakeholders assume the responsibility to engage actively in the consensus process.

4.2 Tomales Bay Watershed Stewardship Plan

In 2003, the Council finalized a watershed stewardship plan and identified four action items, in large part driven by water quality concerns. These actions focused on (1) developing a water quality monitoring plan, (2) reducing non-point sources of water pollution, (3) protecting and restoring habitat and (4) educating the public. To implement these four action items the Council adopted a system of task-oriented sub-committees, including Water Quality, Habitat/Geomorphology, and Education and Outreach, which members felt was both effective and productive. Executive and Funding Committees were also convened, as was a Science Committee, which acted as an advisor to sub-committees when appropriate. In addition, local and agency experts, who sat on these committees, provided technical assistance or were called on for help when needed.

All Council committees are open to the public; council members may attend any committee meeting they wish. Committees meet on an as needed basis to develop specific recommendations, draft documents or funding proposals and to compile correspondence relevant for consideration and approval by the full Council. The Council's bylaws outline the procedures for soliciting Council endorsement or approval. As a principle, the consensus procedures are applied to deliberations at the committee level and in the full Council.

5 Monitoring Water Quality in the Tomales Bay Watershed

The Tomales Bay Watershed Council has always ranked protection and improvement of water quality as a high priority for action. The water in the bay and in tributary creeks defines life in the aquatic environment, and our actions as human inhabitants can have demonstrable effects on the quality of this water. Before the Council formally convened, County, State and Federal agencies, non-profit groups and academic representatives began monitoring water quality. The Council has provided a forum for these groups to discuss their findings and, in some cases, to coordinate efforts. Much of the detailed collaborative efforts were achieved through working groups and committees that brought together representatives of concerned members.

To address water quality issues within this forum, the Council formed a Water Quality Committee in 2005. David Lewis, of the University of California Cooperative Extension, was instrumental in helping to successfully invite and secure agricultural participation, along with the agencies, environmental groups and concerned community members. Specifically, the Water Quality Committee brought together representatives from Marin County agencies – Environmental Health Services (MCEHS), Stormwater Pollution Prevention Program (MCSTOPPP), California State agencies – SF Regional Water Quality Control Board (RWQCB), Department of Fish and Game (CDFG), Department of Public Health (DPH), Point Reyes National Seashore (NPS – PRNS), Public Utilities Districts – Marin Municipal Water District (MMWD), and Inverness Public Utility District (IPUD) and more recently North Marin Water District (NMWD). Also at the table were commercial mariculture representatives, the University of California Cooperative Extension (UCCE) and non-profit groups – Salmon Protection and Awareness Network (SPAWN) and Marin Resource Conservation District (Marin RCD). They were charged with development of a Water Quality Monitoring Program, which the Council created and has successfully funded with a California Proposition 50 grant for 4 years.

The committee has provided a forum to explore ways to understand, improve and coordinate water quality monitoring efforts and to disseminate monitoring results. In addition, the Council itself has been awarded multiple grants to conduct monitoring on rural storm water systems and on public recreational beaches, and to integrate water quality monitoring on a watershed-scale with a major wetland restoration at the head of Tomales Bay.

In the first example, storm water monitoring, the Council partnered with MCSTOPPP to evaluate the effluent from three rural storm water systems in the watershed to determine sources of pollution. This monitoring data provided a basis for a group of local residents in Woodacre, a West Marin community, to launch a feasibility study for a community septic solution.

In the second example, recreational beach monitoring, the Council partnered with MCEHS to monitor bacteria levels at several important local swimming locations. These results were used to determine when advisory postings were necessary to warn the public about potential health hazards posed by water contact.

In the final example, watershed-scale monitoring integrated with wetland restoration, the Council partnered with the Point Reyes National Seashore Association (PRNSA) to monitor water quality at long-term fixed locations throughout the watershed, including sites in the restoration project area itself, and in selected sub-watersheds that may be sources of pollution. This continuing effort is the largest yet to compile data from the entire watershed consistent with data collected from past efforts by agencies, non-governmental organizations and academic researchers. The intent of this collaborative effort is to characterize the long-term water quality trends in the bay and in the watershed.

By building the capacity to conduct scientifically sound water quality monitoring the Council is now in the position to facilitate existing monitoring efforts by its members. It does this by reducing duplicative efforts, by supporting local understanding of water quality issues and possible solutions, by developing a database of all water quality testing efforts, and by disseminating valid and useful results to regulatory agencies, resource management professionals and the public. These capabilities were created and fostered through the collaborative process adopted by the Tomales Bay Watershed Council.

6 Consensus at Work

When the Water Quality committee first convened in 2005, recommendations were usually well received and the participants who provided reasonable modifications to the recommendations felt valued and “listened to.” However, as the project unfolded and became more specific, sensitive topics such as water quality sampling near private lands were evident. Specifically, since agriculture and septic systems were considered to be the most significant activities affecting water quality in Tomales Bay and its tributaries, agricultural operators and private owners felt that data collected could be used to force them to implement remediation if they were the source of pollution. This sentiment prevailed despite the Council's decision to collect data with the express intent that it would not be used for enforcement and that it would not act on behalf of any agency responsible for enforcing water quality standards.

When conflict became apparent, the Council recognized the need to go slowly if it was to achieve progress. This was acceptable to most Council members. However, others who felt an urgency to understand and to address existing water quality problems grew increasingly frustrated. As a result, at least one member, who felt that the efforts were at an impasse, left the Council. Two agricultural members (one representing the Marin RCD and another local community member representative) also left because they did not want the program to continue. As a consequence, the scope of the water quality program had to be pared down and structured to fit the consensus framework of the remaining stakeholders. The Council then worked to build a program as comprehensive as possible which would reflect the complexities of the watershed ecosystems. This program addressed specific objectives: measure trends, identify "problem areas" of Tomales Bay and its tributaries to understand sources of pollution, assess how bay ecosystems responded to storm events and determine if restoration efforts were effective. It also defined a sampling protocol (parameters and locations) to collect the data required to answer questions raised by the assessment. Furthermore, to acknowledge the ranchers' and dairy operators' concerns that any sampling could be used as a basis for enforcement the Council selected sampling locations that could not pinpoint a particular property. The advantage of this design was to provide a structure that could be expanded later to include agricultural and private interests when possible. Practically, through a consensus decision process the Council was able to create and support a 4-year watershed-scale program.

The Council's program looks at problem areas in the watershed using source area sampling and has begun a trend program to detect whether water quality in Tomales Bay and its tributaries is improving or degrading. In contrast, other monitoring efforts, which have been ongoing for nearly 20 years, were often done on a much smaller scale, and sampling was often only intermittent. These monitoring efforts were able to identify the existence of a problem but could not clearly define them.

If the Council continues this program for another 5 years and develops a database that includes historical data, the data it collects and the data other organizations are currently collecting, then it will be able to provide quantitative data on Tomales Bay to understand better the state of its ecosystem. It may also identify opportunities for improvement that are beneficial to all stakeholders.

The next step in expanding the scope of the water quality program is to bring agricultural interests back into the fold as the absence of agricultural participation in this committee is a notable and an ongoing challenge for a consensus-building process. Indeed, agriculture was central in the creation of the Council and is recognized as an activity that strongly influences the health of the bay. This task can only be achieved through a critical analysis of the lessons the Council has learned using its consensus process. By understanding why some decisions were successful and why others failed, the Council may be able to shift its perspective on water quality monitoring and build an entirely new framework acceptable to all stakeholders. The point is not that water quality monitoring will be any less robust, but that stakeholders' vision will become more inclusive. A comprehensive ecosystem wide water monitoring program can and will help agriculture. It will support, and possibly guide, individual efforts as well as the long-term plans of the Marin RCD to implement best management practices on agricultural lands.

7 Working Toward Consensus

One lesson learned is that a functioning consensus process requires the participation of representatives from all stakeholder groups. This can be challenging when there is distrust between stakeholders. For instance, regulatory agencies represent the public interest in the resource, but they are often perceived as outsiders imposing restrictions on people more directly involved in its use. Historic disputes over regulation of waste from ranching operations on the east shore of Tomales Bay underline the fundamental issues between these groups (Avery 2009). So many ranchers feel such regulation places an undue burden on them, which may cripple their ability to continue ranching. However, several examples of regulatory implementation that have taken place in the watershed illustrate the potential to apply regulations in a flexible manner. One is the pathogen Total Maximum Daily Load (TMDL) program implemented by the RWQCB under the Clean Water Act 303d-list of impaired water bodies which focused on improving trends in pollution loading rather than compliance to strict numeric targets. The grazing waiver implementation, which provides an alternate mechanism to comply with non-point source discharge permit regulations, is a positive outcome of the TMDL program.

More generally, the establishment of the TBWC water quality program raised concerns from agricultural and private homeowner interests that culminated in a disagreement focused on the guarantee that the data collected would not be used to enforce but rather to educate and direct productive outcomes. While the Council acknowledged the concerns raised, there was no mechanism to work through these concerns in a timely manner so that the council could gain access to agricultural lands for water quality sampling.

Other disagreements within the Council stemmed from attempts to prioritize monitoring and restoration projects to improve water quality. In some cases stakeholders who felt that their interests were threatened used the process to if not block changes, then make it difficult to move forward. For example, when drafting the stewardship plan, agricultural interests did not want a comprehensive assessment of water divergences from small streams in the watershed and threatened to quit the process if this went forward (Baty 2010). Most recently, stakeholders expressed concern that the Council's Chicken Ranch Beach restoration project would compete with limited funding and with other stakeholder agendas. Perhaps the most difficult conflict the council faces today is between those who see Tomales Bay watershed as rich in resources to exploit, be they agriculture, real estate or tourism and those who, as one stakeholder put it, see the watershed as "an ecosystem with its own natural and intrinsic values that should not be perceived solely as a bankable anthropocentric 'resource'" (Baty 2010).

These conflicts significantly altered the consensus process, which may have been diluted from the Council's inception. For example, during the debate which led to the creation of the council, two key stakeholders, Ellen Strauss of Strauss Dairy and Thomas Baty, a local environmentalist, who had attended all meetings of the Tomales Bay Advisory Committee, the Council's precursor, and who had provided important perspectives, balked at participating. Moreover, some participants wanted to exclude government agencies. As Seraydarian (2010) points out,

> The largest issue in organizing the Council was the local resentment of federal and state agencies. The National Park Service had historically acquired lands in the watershed and some feared they would continue. Locals resented the actions of some of the state regulatory agencies. Some (who considered themselves) the true "locals" wanted to exclude agencies or not have them vote as Council members (email).

Many stakeholders, but certainly not all, felt that the consensus process, which in theory gave everyone the chance to voice his or her concerns, helped members work together while others considered it too time consuming and inhibiting. In short, adopting a consensus decision-making process was contentious from the Council's beginning.

Despite this, the specific disagreement on water quality monitoring provides an opportunity to identify the flaws in the implementation of the consensus process and to open possibilities to restore or strengthen it in the future. Indeed, with its current program, the TBWC could operate as an independent party to provide data to determine the effectiveness of management practices, to partner with members to find funding to implement effective practices, and to work with regulators to implement effective regulations. With such positive outcomes the council could then seek a deeper engagement of the RCD in the Council. The RCD is a key forum for rangeland management decisions, and its programs have been responsible for the implementation of best management practices on many ranches in the watershed. With the renewed involvement of RCD in the Council, it will become possible to monitor specific improvement projects for water quality to demonstrate the effectiveness of RCD projects.

The Council's access to and involvement with the farming and ranching communities would provide the opportunity to collect water quality monitoring data that would support the contention that best management practices are effective at optimizing agricultural operations and at reducing water pollution. These data would help bolster the Council's position with regulators and could lead to a regulation framework that would be acceptable to all parties. However, there is still a rift between the RCD and the Council, and until there is accord and willingness to work together, water quality monitoring will not be as robust as it should be.

Ultimately, the perceptual schism between the bay as a "resource" and the bay as a uniquely natural environment will only be bridged with a shift to a more comprehensive perspective such as an integrated ecosystem approach, which addresses the complexity of an environment within which problems may stem.

Central to such an approach is the focus on the formal representations of ecosystems. This will help us understand the overall structure of our environment and will also shape how we define emerging problems and possibly solve them. This approach identifies and clearly states problems rather than defines a path to pre-ordained solutions of *perceived* problems.

Emphasizing ecosystem representation has the advantage of conceptualizing a specific ecosystem's components with "variables" and "parameters" that are *familiar* to the stakeholders. Doing so facilitates dialogue and helps stakeholders build an agreed upon set of important concepts independent of any problem or issue. It also fosters the need to make explicit the known dynamic relationships that exist between these components. This approach has the advantage of inherently challenging a-priori constraints and prejudices (e.g., the scope of property rights, the level of play on the interface between wilderness and developed land) not by thinking out of the box but by re-inventing it.

Although agencies may claim to practice ecosystem-based management, stakeholders must understand specifically what this means within the process of ecosystem characterization. Indeed relevant agencies *must* also participate in this process on the same level as other stakeholders. Mandated by law, they are the guardians of the practical constraints to ecosystems. The resulting structure of components and relationships becomes a direct partner in the conversation with stakeholders about the changes to the ecosystem that need to be considered.

An integrated ecosystem perspective recognizes the plasticity of an ecosystem's structure and when new questions emerge, demands collective modifications. Although collective effort is no easy task, this approach promises a more comprehensive tool to help identify and resolve problems that emerge during an ecosystem's evolution. This demands commitment from all stakeholders along with the cultivation of self-reflexivity (the ability to criticize and change one's position), an unabashed display of expertise and unimpeachable integrity.

Full stakeholder participation, collaboration between stakeholders and the collective invention of a unified vision of the watershed shared by all stakeholders is the key to restoring the necessary framework and the intent of consensus-based decision making.

Too often self-interest has been the driving force behind actions and decisions in community organizations. Too often stakeholders have refused to see the larger picture and to acknowledge the complexity that is our world. Historian David Christian (2005) reminds us that "current rates (of extinction) appear similar to the five or six most drastic extinction areas" in the 600 million years paleontologists have been surveying (142). We may continue on this path to extinction. Or we may well be at the threshold of a path to new possibilities, creating innovative and holistic ways of thinking and of being. The decisions we make in our daily life in our watershed councils put us squarely on our path.

Ultimately, the choice is ours.

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Chapter 21
Outcomes of Social-Ecological Experiments in Near-Shore Marine Environments: Cognitive Interpretation of the Impact of Changes in Fishing Gear Type on Ecosystem Form and Function

Charles G. Curtin and Sarah Hammitt

Abstract The environment is undergoing profound change due to climatic and other anthropogenic related factors. However, we often cannot anticipate the changes before they happen and thus do not have effective base-lines for decision making, or good means of assessing the rate and extent of change. At the same time even if we could anticipate these changes, the cost of developing sufficient biological data would often be prohibitive. This paper explores the use of social data, to address biological questions. In this example we examine the resilience of near shore marine systems ability to respond to a reduction in fishing pressure as a proxy for understanding the broader ability of the system to adapt to change.

Keywords Climate • Fisheries • Resilience • Socio-ecological interactions • Mid-water trawling

1 Introduction

Restoring and protecting marine "lands" pose an especially difficult challenge. As true common pool resources, how can they be shared and the resources they support not be exploited to depletion and the ecosystem destroyed beyond recovery? Recent changes in marine policy provide a series of social-ecological experiments that test the ability of ecological systems to recover following long-term disturbance, (e.g., Holling 1973). Rapidly changing climate will alter (and already is altering) ecological systems and social systems. Much of the climate change discussion to

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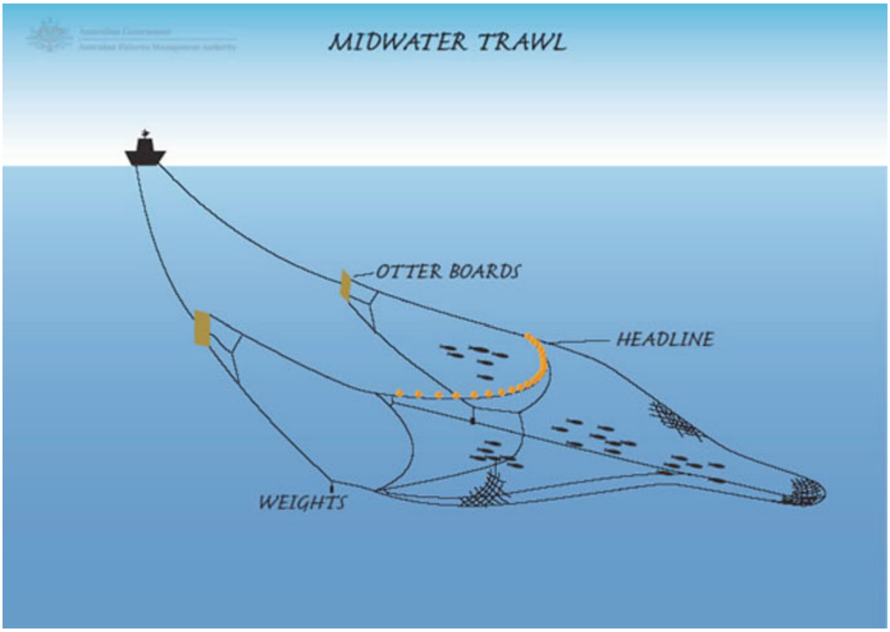

Fig. 21.1 Mid-water trawling is intended to pull a net through the water column. However, in shallow near-shore waters the net actually is often dragged on the bottom essentially harvesting species from the entire water column and resulting in high levels of by-catch of non-target species. Fishermen of non-trawling boats have perceived this to have immense impacts on all manner of fisheries and the ecosystem in general (Source: Australia Government: http://www.afma.gov.au/information/students/methods/midwater.htm)

date has focused on global effects. However, it is important to understand the effects of human activities on natural systems across scales (local to global) so policies can accommodate and adapt to the uncertainties climate change (Brunner and Lynch 2010; Curtin 2012). This chapter examines the case of Maine fisheries for the general lessons it imparts about the ability of cultural and ecological systems to respond to change at local and regional scales, and as a lesson in the importance of coordinating science (both expert and local knowledge) and policy for effective restoration of natural systems. In so doing, it becomes apparent that the well being of social systems, economic systems, and natural systems are dependent on one and another.

In this example, for more then a decade corporate trawlers fished for baitfish such as herring in the middle of the water column (Fig. 21.1). In the face of mounting concern that these practices were too efficient at taking fish, and in particular that the nets were also dragging the bottom taking spawning herring and ground fish such as cod, the process was terminated for the summer in the near shore waters of Maine beginning in 2007. This practice has been, in essence, an unintended experiment to assess the resilience of the system; and provided opportunities to explore the utility of rapid social assessments of environmental problems. For many challenges such as the one depicted here even if we had the foresight or ability to anticipate the changes in policy, we would be unlikely to raise the tens or hundreds of thousands of dollars it would take to assess these changes using conventional biological methods. In a period of increasingly dramatic environmental and social upheaval, and declining funds for science, finding alternative approaches is essential for understanding the implications of change. People's minds are remarkable integrators of information and they are able to detect details that may escape conventional analysis. Fishers, farmers, ranchers and other observers whose livelihoods or very survival depends on their ability to detect environmental change are especially sensitive to changes in the environment that might not be noticed by conventional scientific analysis. The policy experiments described herein essentially also serve as a proxy for environmental change testing both the utility of social methods, and the systems ability to rebound.

For years fishers, scientists, and conservation groups (among others) have charged that increasing levels of fishing pressure were destroying marine ecosystems. In work on groundfish restoration early in the first few years of the twenty-first century, the most common cause of decline cited was midwater trawling (Curtin and Wilson 2006, unpublished). As fishermen Ted Ames frequently states "no food, no fish." Stating a common concern among fishers that the decline of the diversity and density of fish in the Gulf of Maine in general, and near shore waters in particular, though a result of a whole range of processes, was primarily attributable to the loss of bait fish that formed the bottom of the food chain. This study examines both the implications of fishers' knowledge and the ability to use local knowledge for environmental problem solving.

1.1 Reversing Ecosystem Decline

People for thousands of years have impacted near shore fisheries in the Gulf of Maine and across the globe (Turner et al. 1990; Bourque 1995; Christensen et al. 2003; Curtin 2012). On the Turner Farm archeological site in the heart of our project area the record from fish bones in middens suggests that even thousands of years ago well before the coming of Europeans that the "red paint people" and their descendants were already altering marine communities (Bourque 1995). These changes accelerated in recent centuries and particularly in recent decades. Local fishermen and others speak of the dramatic changes as the system went from weirs and other localized efforts prior to Word War II, to increasingly mechanized fishing after the war that included purse seines and the use of aerial spotters, to finally midwater trawlers. Each technique was more devastatingly efficient than the last until by the late 1990s local fisheries had been depleted. To survive fishers shifted to harvesting different species with unintended consequence to the sustainability of the "web of life." For example, as the extent and intensity of lobster fishing grew the fishing industry was in essence increasingly severing the very structure of marine ecosystems by harvesting the middle or lower portions of the food chain and using it to feed bottom dwelling scavengers.

As it turns out these bottom feeders are extremely lucrative economically and as lobster numbers rose all along the coast a newfound prosperity was evidenced among fishers. Lobstering went from being a portion of fishers' incomes in a diverse and almost subsistence income to the largest fishery in Maine with lobster fishers frequently making over 100 k a year in a cash economy. As one young lobster fisher stated, the smell of bait on lobster fishers after a day of work was "the smell of money."

This new found affluence and the increasing focus on the lobster fishery, coupled with increasingly effective harvesting methods, had a number of indirect social consequences and implications in addition to the biological ones discussed above. As bait fishing went from a local community or family operated weirs to corporate efforts in increasingly large and technically sophisticated boats it displaced local effort and the number of licensed fin fishing boats on the coast of Maine went from over 70 to 7 in central Maine and to 0 in Eastern Maine.

This economic simplification (dependence on a single species for income) has profound implications at a number of levels. First, lobster fishing, though extremely lucrative, is probably not sustainable because no single fishery has ever survived an extended period of time. Bringing back a diversity of fisheries is not just important for the ecological health of the system it also is key for economic viability; a collapse, or even modest decline in the lobster fishery would devastate local economies. Second, other kinds of fishing have long been a part of local culture and a loss of them represents a loss of hard-won local knowledge. Finally, a diversity of fisheries represented a diversity of livelihoods on land. Everything from engine mechanics to net makers was lost with the simplification of the fishery; thus, the indirect and synergistic effects of shifts in fishing practices are huge.

1.1.1 Methods

Sample Group

Fishermen were identified for involvement in the study with help from The Island Institute of Rockland, Maine and the Penobscot East Resource Center of Stonington, Maine. Fishermen were prioritized for their past or present involvement in the herring fishery. Additional fishermen were identified from the lobster fishery due to the close ties to the herring fishery for bait.

Initially, four herring and three lobster fishermen were identified for interviews. Herring and lobster are the primary fisheries that the fishermen are involved in currently; however, each of the fishermen had experience with other fisheries over their careers. From these initial interviewees, three additional herring and one lobster fisher were recommended for interviews. The multiple layers of interviewee identification is known as the "snowball" method.

There was initially a concern that the sample group would be biased due to their prior involvement with community organizations such as the Island Institute and PERC, a form of self-selection. However, it was soon realized that only a couple dozen active fishermen remain on the entire coast of central and eastern Maine with experience in herring fishing. By interviewing seven fishermen (and lobster fishermen, the researcher would interview nearly 50% of the remaining population of herring fishermen). The researchers were confident, therefore, that the sample group would be representative of the population of fishermen on the coast of Maine.

Semi-structured Interviews

Eleven semi-structured interviews were carried out in February and March 2009 (by Hammitt). Two interviews were carried out over the phone because one fisherman was in Florida for the winter and another lives on the island of North Haven. Nine interviews were conducted in person. Each fisherman was initially contacted by phone by Hammitt to introduce the project and to ascertain the fishermen's willingness to participate in the project. Each fisherman accepted readily.

Once the list of interviewees was set, the fishermen were contacted a second time to arrange dates and meeting places (or simply dates in the case of the two phone interviews). The researcher asked the interviewees to choose the meeting places themselves, both to ensure that the place was convenient to them, and to ensure that the place was a comfortable, "safe space" for the interviewee in case sensitive information were to arise.

Hammitt traveled to each interview location with a digital recorder, a laptop, and a local nautical chart. The permission of each interviewee was requested for use of the recorder. The nautical chart was used to facilitate recollection to answer questions, as a clarification device when specific marine areas were discussed, and also as a conversation piece to take attention away from the one-on-one interview setup, which can be uncomfortable for some people.

Each interview began with a formal explanation of the project, and an explanation of the interviewees' rights, a hard copy of which was signed by each participant.[1]

The interviews followed a semi-structured format, so as to facilitate an open, free-flowing conversation. All intended topics were touched on, though not necessarily in the same order. Questions were open-ended and structured to be interpreted as neutral. Admittedly, given the occupations of the fishermen and their investment in the fish stocks for their livelihoods, it was anticipated that the fishermen would be passionate and opinionated. It was expected that open-ended questions regarding the 2007/2008 ban on mid-water trawling (MWT) might evoke strong feelings. In preparation for this, the researcher attempted to separate concrete messages about

[1]Note that the semi-structured interview approach, as well as the questionnaire was approved for exemption the MIT Committee on the Use of Humans as Experimental Subjects.

changes in the herring stock from negative feelings about the method of MWT. Each interview lasted approximately 1 to 2 h.

Written notes and the recordings were later transcribed and categorized into themes. The themes included:

1. Changes in the herring stock
2. Ecological and environmental changes
3. The impact of MWT
4. The impact of the ban on MWT
5. Indicators of the herring stock

The fishermen were also asked for basic demographic information including age, home port, experience, and fishing gear/techniques.

1.1.2 Local Knowledge Cognitive Mapping

The indicators of the herring stock were particularly important for the purpose of cognitive mapping. Towards the end of each interview the fisherman was asked to work with the researcher to develop a cognitive map of their local knowledge. Using CmapTools,[2] the fisherman and the researcher mapped the various elements of the fisherman's local environment, both on the water and on land, ecological and social, which contribute to the fisherman's assessment that a fish stock is healthy, unhealthy, and/or changing.

Following the interviews, the 11 individual maps were combined to form 3 local knowledge maps for social, ecological, and historical knowledge. The maps were recreated using Adobe Illustrator and are included as Figs. 21.2, 21.3, and 21.4. They are described further in the results section.

1.1.3 Sample Profile

Every fisherman grew up on the coast of Maine and ten grew up fishing with their families. The men are strongly rooted in the Maine fishing community and have over 310 years of combined fishing experience. The sample group's age range was from 25 to 76 years. The group of 11 fishermen comprised 7 herring fishermen and 4 lobster fishermen, with additional experience in fishing for scalloping, oystering, urchins, clamming, crab fishing, gillnetting, sword fishing, and cod fishing. The fishermen haled from North Haven Island (2), Rockland (1), Stonington (4), and Beals Island (4).

[2]CmapTools was developed by the Institute for Human and Machine Cognition (IHMC), a university-affiliated research institute of Florida: http://cmap.ihmc.us/conceptmap.html

Fig. 21.2 Perceptions of the health of the herring stock: ecological networks (Figure Key: Color and size of the circle indicates the number of fishermen who cited the indicator)

1.1.4 Results

Changes in the Herring Fishery

Fishermen must strike a balance between fighting for regulations to sustain a healthy fishery and fighting for a sufficient allowable catch to support their families. Thus, the fishermen's comments had to be considered through that lens. Although there were a number of concerns about the future of the herring fishery, there was general agreement that the herring stock is doing relatively well and that the TAC (Total Allowable Catch) is too low.

Fishermen describe the herring stocks today as being less plentiful and more fragmented than in the past. There was consensus that the herring stock has decreased

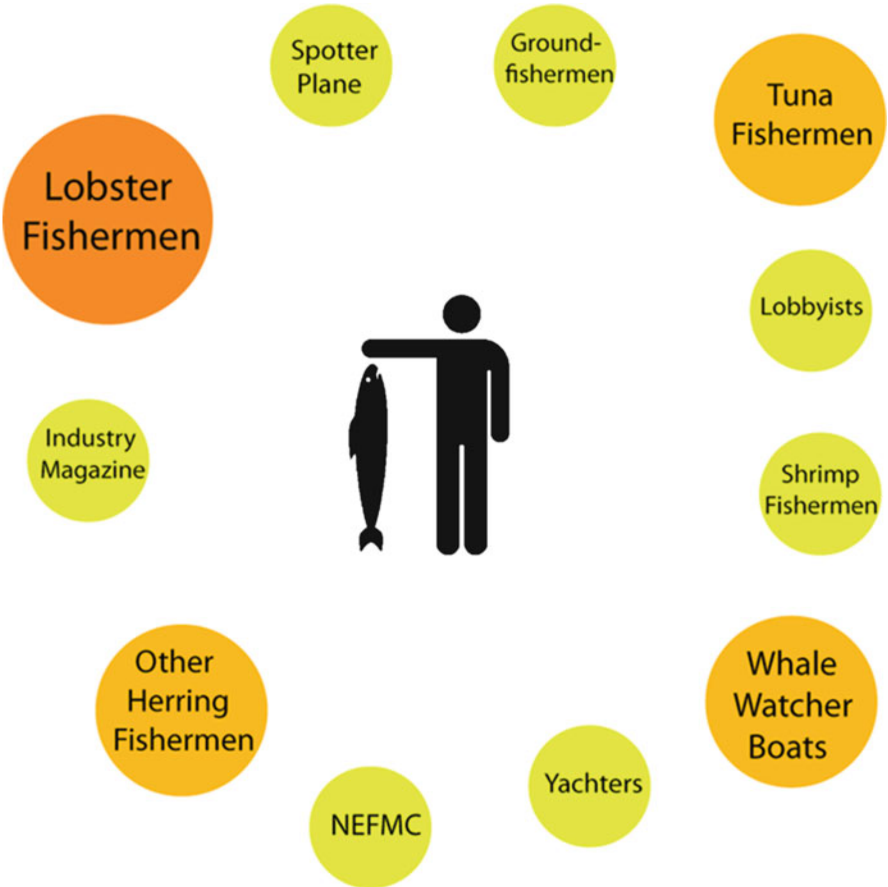

Fig. 21.3 Perceptions of the health of the herring stock: social networks (Figure Key: Color and size of the circle indicates the number of fishermen who cited the indicator 1 2 3)

over the careers of each fisherman stretching back to the earliest memories in the 1930s and 1940s.Not only did the fishermen describe the herring stock as being more abundant in the past, they also described very different herring population dynamics. Through the 1960s, herring was abundant and ubiquitous in the near-shore areas all along the coast. Herring came right up to the shoreline and weir fishing was common. The coves would fill with herring and stop seining was a profitable method. The coast had *"a dory in every cove."*

The decreases in the herring stock were mostly gradual, though some fishermen describe periods of faster decline when new equipment was introduced, such as purse seining in the late 1960s and MWT in the 1990s. The herring schools began to break up and populations began to decrease due to purse seining. The stock began to move offshore in the 1970s and now nearly all herring are caught in the off-shore areas.

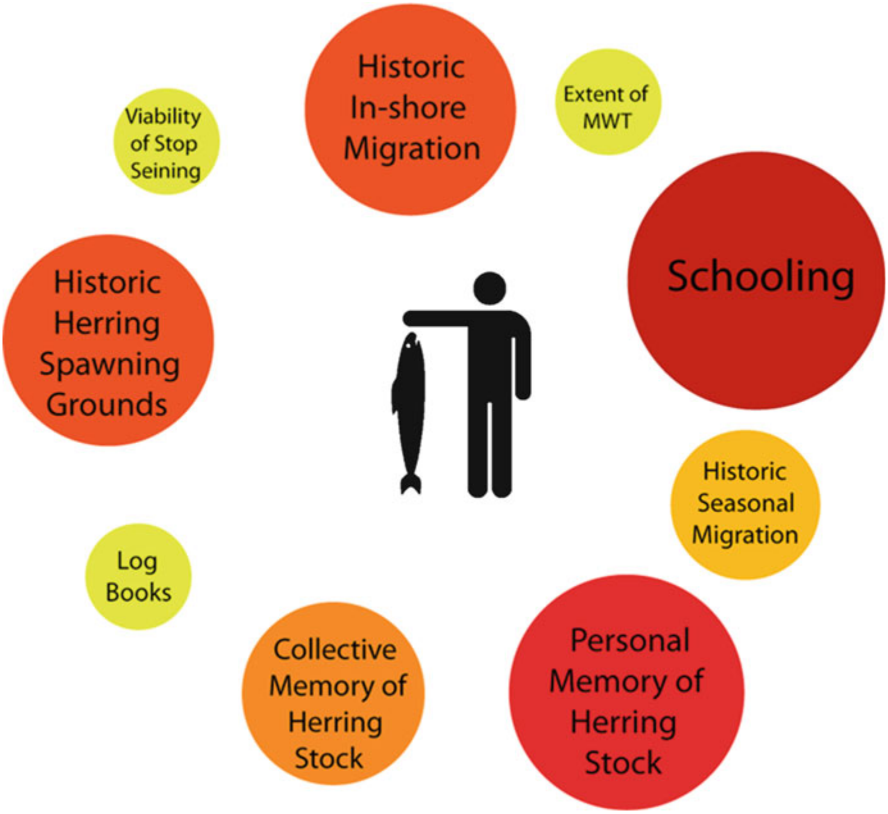

Fig. 21.4 Perceptions of the health of the herring stock: historical knowledge (Figure Key: Color and size of the circle indicates the number of fishermen who cited the indicator)

The introduction of MWT in the 1990s did not immediately cause a steep decline in the herring stock because the influx of trawlers was gradual. However, the fishermen observed drastic changes in the herring stock as the number of MWT increased, as the trawlers got bigger, and with the induction of pair trawling (two trawlers dragging an bigger net in tandem).

Fishermen describe the recent population dynamics of herring schools as being very different from their memories before widespread MWT. A healthy school of herring may be miles wide and several feet deep. From a spotter plane, the fish will look like a dark mass moving along the coast. Up close, the school is highly graded into different size fish. This is thought to be a result of different age classes sticking together. There are also distinct herring families, which have different bodily characteristics that the older fishermen are able to describe.[3] Families travel in distinct schools.

[3]A wider body distinguished winter migrating herring; spring spawning herring were found in the Bay of Fundy; and fall spawning herring were always the biggest.

A school of herring off the coast of Maine in 2006, however, which may have been picked at on the edges by purse seiners, and driven through by MWT, looks very different. The pair trawlers drive the fish apart, scattering them into smaller schools. The persistent dragging of the trawlers up and down the schools means that the school does not have a chance to reform. Purse seiners must redouble their efforts to catch the same amount of herring because the density is so depleted. Herring seek safety with any other herring they find and schools are a mix of all different age classes. It is unclear what the ecological implications might be as a result of this fragmentation and mixing of herring families and age classes.

Particularly hard-hit are the stop seiners who rely on the herring coming in-shore.[4] The fishermen remember the herring coming in-shore and staying around for a couple of months or even all summer. Now the maximum is 2 weeks, if any make it in-shore. According to the stop seiners, the purse seiners and MWT break up the schools before they even make it to the bay. In addition to the dynamics of the populations within the schools, fishermen have noticed changes in herring migration and population cycles. Whereas older fishermen used to be "able to set their clock by when the herring would start spawning at Seal Island, Monhegan, Isle Au Haut," such consistency seemed to disappear with the advent of MWT. Migration timing and spawning sites are less predictable.

Ecological and Environmental Changes

As the herring populations decreased over the decades and moved offshore, so did many predatory species. For example, fishermen saw fewer dolphin (Lagenorhynchus acutus) and tuna (Thunnus thynnus). The predatory fish were so few that they seemed to stop coming into the Gulf of Maine, as there was simply less feed to attract them. With the MWT ban, fishermen observed more predatory species coming in-shore in numbers that they had not seen "in I don't know how long." Ironically, stripers (Morone saxatilis) were now not biting because they had more than enough feed in the water.

The fisherman listed many changes in the environment over their careers, though there was no large agreement on the impacts of these changes on the herring fishery. Such changes in the environment included warmer winters and resultant changes in timing and amount of spring run-off, salinity, nutrient concentrations in the water, sedimentation, and near-shore water temperature. One fisherman noted that freshwater runoff pushes the herring offshore. Another asserted that herring like freshwater and the nutrients that the runoff brings and that herring prefer coves with warm mudflats of sufficient nutrient input. Two fishermen noted that pollution has pushed herring offshore, a phenomenon that was observed 10–15 years before MWT from chlorine and detergents in the water. This fisherman is hopeful that the closing of a paper mill

[4] Ironically though stop seines now seem relatively low-tech and low impact, on many of the islands fishermen consistently cite the stop sieners as having the first big impact on nearshore fish populations beginning in the 1960s, with many of the smelt runs gone by the mid 1970s.

upstream will help to bring herring in-shore and another mentioned the opening of rivers from dams, which will allow for more natural sedimentation as well as upstream spawning. The Clean Water Act was very effective for improving the in-shore water quality, which was previously plagued by paper mills, GAC chemical plant, and a superfund site. Reduced pollution and more natural nutrient runoff may help to revive plankton, on which herring feed, and which have also moved offshore in recent decades. Water turbidity was blamed for smothering the eel grass, which requires light; herring hide in eel grass when they come in-shore and the eel grass is coming back.

The Impact of Mid-water Trawling

The fishermen were unanimous that MWT is too destructive and too efficient to maintain a sustainable yield of herring. As discussed above, MWT are known to break up large schools and trawl back and forth through the schools until any concentration of fish has been caught or broken up. MWT are indiscriminate in their catches and they speed along too fast for escape; anything that gets in the way will be caught in the net. This also drives away or kills predatory fish. Landing restrictions for types of fish mean that if a trawler brings up too high a percentage of a non-herring fish, the MWT will dump the load.[5] This indiscriminateness carries over to economic damage as well; MWT cause trouble for lobster fishermen who regularly have their lobster pots dragged off in the night.

MWT is a constant fishing operation and, once discovered, schools have no opportunity to recover. The operations run three boats at a time, each carrying one million pounds in their enormous holding tanks, which they offload in Gloucester, MA. In this way, MWT is also harmful to Maine's coastal communities. The trawlers are based out of Massachusetts, and frequently employ people from the UK, Scotland, and Ireland, and deplete the local resources without contributing to the local economies.

Many fishermen believe that the name "mid-water" is deceiving and that the trawlers frequently scrape the ocean bottom. This is evidenced by the need for rock-hoppers on the bottom of the nets and frequent snagged net repairs. There is great debate over whether or not MWT collects spawning herring, which hover on the ocean bottom. The purse seiners interviewed asserted that the MWT definitely kill spawning herring. On the other hand, stop seiners say that both purse seiners and MWT bring up spawn herring and argue that spawning grounds should be closed off altogether to any fishing method. It is unclear as of yet if the ban on MWT will have an impact on the decimated ground fish populations in the Gulf of Maine. Although a rebound of ground fish has not been observed, ground fishermen are hopeful.

[5]Purse seining is also indiscriminate and must off-load catches that have too much of a restricted species. This means that both the herring and the regulated fish are killed anyway, but are then also thrown away to rot. Stop seining allows the fisherman to be more discriminate in his catch.

Many in the coastal community, therefore, are hopeful that the ban on MWT in the summer months will better protect the spawning ground fish and allow the populations to recover.

It was clear that all of the fishermen are concerned about the unknown long-term environmental impacts of MWT. Three fishermen stated that they would support a permanent ban on MWT. As one fisherman put it, “mid-water trawlers have no place in the Gulf of Maine.”

The Impact of the Ban on Mid-water Trawling

Summer 2007: “The ocean came alive again!”

All four of the active herring fishermen asserted that herring came back in the summer of 2007 and three of four characterized the change as “immediate.” According to one herring fishermen, “herring came back like a light switch and were coming into the coves again and showed up in huge numbers.” Even the purse seiners were able to catch herring in-shore, which they had not done to a large extent since the 1970s. There was immediate speculation that the comeback was a logical result of the MWT ban. At the same time, some members of the community were quickly skeptical that the rebound must be a fluke, just too good to be true. The herring schools in 2007 were described as consisting of a variety of age classes.

Summer 2008: “Bodes well for herring along the coast of Maine.”

The fishermen all described the general difficulties of predicting the success of an upcoming fishing season. While herring stocks seem to follow long-term cycles of approximately 10 years of upswings and downswings, there are no certain environmental signals to indicate that a single season would present little or lots of herring. To be sure, no one would have predicted the stock in 2008. The herring was more abundant than the fishermen had seen in several years and again the schools were coming in-shore. But the vast majority was bric (herring almost too small to harvest). The fishermen easily met the TAC and were disappointed that they could not harvest more.

Indicators of the Herring Stock

The fishermen were asked to conduct a cognitive mapping exercise to map the indicators that contribute to the fishermen’s perception of a fish stock. The fishermen were asked to imagine being on the water or in the community and to brainstorm the various factors that indicate the health of the herring stock. We compiled and tallied the indicators and developed three cognitive maps, included as Figs. 21.2, 21.3, and 21.4.

Figure 21.2 illustrates the ecological indicators that fishermen experience on a day-to-day basis on the water while fishing, and which trigger a sense of the herring stock’s health. The presence of various predatory fish, for example, is a good indicator of a healthy herring stock because they come to feed on the herring. More herring attract more predators. The presence of predatory fish increased according to several fishermen in 2007 and 2008 with the summer ban on MWT. It is also noteworthy that the stop seiners, who traditionally work closest to shore, cited runoff and stream pollution as factors that impact the health of the herring stock.

Figure 21.3 presents the social network that a local fisherman works within. A variety of community sources provide indicators to herring fishermen that the herring stock is healthy or not. In a tight-knit community, such as those along the coast of Maine, friends help each other out to make the catch. This is due to recognition of mutual benefit. For example, the lobster fishermen will inform herring fishermen if they see a school because locally caught herring is cheaper than imported and fresh bait is more effective at catching lobster.

In other ways, the interconnectedness of a local economy benefits herring fishermen because everyone is reliant on a healthy ecosystem. An example of this is the whale watching boats; a healthy herring stock will draw whales to the coast and improve whale sightings, increasing tourist demand for such tours. Herring fishermen are also attuned to the institutional and political forces that influence their fishery. Fishermen mentioned the NEFMC (New England Fisheries Management Council), lobbyists, and a popular industry magazine as influencing their perception of the health of the herring stock.

Finally, Fig. 21.4 illustrates the historical knowledge to which local fishermen are privy. It was in this mapping category that the highest frequency of specific indicators were mentioned. The historical knowledge reached as far back as the fishermen's individual childhood memories, and even parents' and grandparents' memories. The earliest historical knowledge dated back to the 1920s. There were the most references to the health of the herring stock being largely determined by (1) the extent to which herring came into in-shore areas, (2) the extent to which historical herring spawning grounds are protected, and (3) the size/concentration of herring schools. One person also explicitly linked the historical presence of MWT to the health of the stock. Another fishermen mentioned, in connection to in-shore migration, the viability of stop seining as a good indicator of the health of the herring stock.

The reason for the high frequencies in the historical knowledge should be further investigated. Do many fishermen carry similar perceptions because of a shared history? Or are the historical indicators the most important indicators that the research has drawn out? Is this the most important source of local knowledge that should be tapped into by scientists? If sustainability is the goal for the fisheries, it makes sense to take the longest historical perspective possible so that the future goal for sustainable yield can be better calibrated to historic potentials.

Fishing Techniques

In addition to the damage that is caused by MWT, this research highlighted other unexpected conclusions about the herring fishery and fishing techniques. Efficiency has clearly decreased over the past century. Fishermen are using more power to catch the same amount of fish. At the turn of the century, when fishermen relied on smaller fleets and far less technology, fishermen "complained bitterly that they were having to move off-shore a few miles" to catch herring. Today fishermen catch the same amount but require enormous nets, engines, and multi-agent operations. This indicates that the abundance of herring is "way down" (Emily Klein, personal communication, University of New Hampshire).

In addition, the interviews revealed substantial differences in ecological knowledge between the purse seiners and the stop seiners. Stop seiners rely on the whims of herring schools and must time their cove closings by the phase of the moon. Their method involves a lot of waiting and observing. Therefore, stop seiners are highly attuned to changes in the environment. They were able to identify many more ecological indicators than the lobster fishermen or the purse seiners. But it is worth noting that all perceptions of fishing impacts are relative. Among many older fishermen interviewed stop seines appeared to influence the herring populations long before the mid-water trawlers appeared and they point to weir fishing as the only sustainable method. Whatever the approach it is clear that the importance of local fisheries and local management in paramount as much the relationship between the scale of the fishing to the scale of the fish is key to building stewardship (Wilson 2006).

In complex or "wicked" systems as are typical of most linked social-ecological systems it is hard to provide simple empirical depiction of behavior or outcomes (Rittel 1972; Brown et al. 2010). The approach above illustrates how in systems of increasing complexity, how "soft" approaches can be used the characterize behavior (Checkland 1981), providing a view that is hard to attain through more traditional linear approaches. We propose cognitive mapping as one potential solution to the challenge of finding affordable and timely responses to complex problems (e.g., Brown et al. 2010; Curtin 2012). The social-ecological response to policy provides one example of the utility of this approach, and equally important strongly suggesting that these systems can respond to change, and that midwater trawling appears to be a strong player in this system.

2 Conclusion

The impact on the herring stocks due to the ban on MWT cannot be definitively determined from this study. In anything, the study raises further questions for researchers and policy-makers. For example, it has been argued that the MWT simply switched their gear to purse seining gear for the summer months during the bans. If this means that the fleet pressure remained the same, even with the ban, does this mean that the herring stocks are getting better on their own? Or is this more evidence of the need for gear restrictions?

In the early 1900s, fishermen were calling for more management of the gillnetters because the fishermen could see that the fish stocks were declining. Government representatives visited, saw the abundance of fish in Maine's waters, and called for intensification of resource exploitation. According to one researcher at University of New Hampshire, this significant event first led to fishermen's distrust of governmental fisheries regulators in Maine. Although the motivations of different fishermen need to be taken into account, regulators ought to take the time to sincerely engage with fishermen about the state of marine ecology (Crocker 2008). If fishermen are calling for a ban of a fishing practice, their voices must be heard. Although there are only about two-dozen commercial fin fishermen left in Eastern Maine, they are adamant that MWT is negatively impacting the herring stocks, that the ban on MWT deserves study to determine its effectiveness, and that permanent regulation should be seriously considered.

While the exact form of management is undetermined, a focus on gear type is essential. Local evidence strongly suggests that intensive methods of the recent past were damaging the herring stocks that are a key facet of the ecosystem. But perhaps more significantly the outcome of this study suggests there is intrinsic resilience still left in the system and that it does have the capacity to rebound. This suggests that in addition to regulating harvesting methods and quotas that other conservation measures, such as dam removal or reintroductions will likely have a pronounced positive impact if effective governance and policy accompanies them. It is necessary to coordinate science (both "expert" and local knowledge), policy, and management for effective action

This paper illustrates the power of cognitive mapping in detecting change and understanding variables the influence communities. Restoring and preserving landscapes and seascapes, will require better governance and more effective feedback loops between resource users and resource managers to understand the consequences of decisions and policy on the resource. In essence moving from single to double- and triple-loop learning that facilitates adaptation to change (Argyris 1993; Peschl 2007; Curtin 2012). As such the fisheries research above is an example of applying post hoc methods which in many situations are the only tools available for effectively coupling socio- and natural science-based perspectives. The synthesis is essential for detecting variability and assessing ecosystem resilience in ecosystems undergoing rapid and unprecedented change.

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Part V
Synthesis

Chapter 22
Synthesis: Developing the Institutions to Coordinate Science, Politics, and Communities for Action to Restore and Sustain Lands

Herman A. Karl, Lynn Scarlett, Juan Carlos Vargas-Moreno, and Michael Flaxman

Abstract Making a leap forward in restoring and sustaining lands requires more than refining conventional approaches for formulating environmental policy and making natural resource decisions. We are in a period of transition and evolution with regard to managing the dynamics of coupled natural and human systems. New forms of governance are emerging. We need institutions that will distill and harness the wisdom residing in diverse societies, facilitate dialogue, and enhance mutual learning about shared problems. We need governance regimes and processes that bridge the gaps among disciplines, methods, and current institutions that include public, private, and academic participants. New institutions and governance regimes will enable an ongoing process of collaborative action and shared decision making that supports durable environmental policy and land use decisions that sustain communities, economies, and the environment.

Keywords Institutional change • Governance • Place-based • Adaptation • Sustainability • Collaboration • Environmental policy • Natural resource management • Leadership • Trust building • Wicked problems • Interdisciplinary research

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1 Introduction

"What is the relation between science and the humanities, and how is it important for human welfare?" We introduced this question in the first chapter. On its face, this seems to be an arcane academic question (Wilson 1998, 13) and not one to consider in a self-described non-academic book.[1] However, answering this question is central and critical to the theme of this book and its support for problem solvers who can tackle wicked problems and enhance sustainability. In 1854 Thoreau (Sayre 1985, 490) anticipated and addressed Wilson's question: the relation between science and the humanities "…is a true *humanity*, or account of human experience." He was referring to the integration of local (practical) understanding with scientific (expert) knowledge. The answer to this question about the relationship of science and the humanities is central to tackling wicked problems. And dealing with wicked problems is essential to sustainability. We now endeavor to translate and transmute Thoreau's philosophical answer into a framework for action by examining the processes and institutions that enable communities to coordinate science, politics, and social action to restore and sustain lands. Let's begin by considering barriers and challenges.

2 Barriers and Challenges

Perhaps the biggest barrier is not listening to what others are saying. The biggest challenge is actively listening and then applying what has been learned.[2]

Many government agencies hold "listening" sessions. Philosopher William Isaacs, in *Dialogue and the Art of Thinking Together,* writes *"to listen is to develop an inner silence." (Isaacs, 84)* Dialogue, he writes, "seeks to harness the 'collective intelligence' of the people around you." (Isaacs, 11) Yet, "active" listening among participants, including agencies, occurs infrequently. Similarly, many citizens do not listen to agency personnel and to each other. Many of us are guilty of not actively listening in our anxiety to have our own voices heard. A key ground rule of any participatory collaborative process is to respectfully listen to each other. Listening can help avoid misunderstanding and enhance shared learning

[1] "It is a tempting and safe academic device to approach any problem from a traditional viewpoint. By so doing we assume that the twenty or so civilizations of man and the few thousand years of recorded history are sufficient to have faced all problems and devised all solutions. Society now seems to be facing problems of resources and environment, however, more intensive and extensive than those experienced in the past" (Holling and Chambers 1973, 13). This was written almost 40 years ago. In this book, we endeavor to present unconventional approaches to dealing with the ever-increasing problems of resources and environment.

[2] John Hagan, president of the Manomet Center for Conservation Sciences, stated, "we need to listen, learn, and apply," at a panel session on Science in the Age of Sound Bites co-sponsored by MIT and Manomet spring 2010. The audience and the rest of the panel, comprising MIT professors, a newspaper reporter, and filmmakers, essentially overlooked his statement; the panel focused on their own messages.

2.1 Science and Technology

"We need to educate the public better in science. We need to train scientists better in how to communicate to the media." Many in the scientific community see these deficiencies (an ignorant public and "non-savvy" scientists) as the principal barriers to the more effective use of science in policy formulation and decision-making. How often have you seen these statements or variations of them as the topic of editorials in scientific journals? Whereas these statements are valid, they do not represent the principal barriers and challenges to the acceptance and more effective use of science by policy makers and the general public.

The major challenge is how to involve people directly in the process of scientific inquiry, analysis, and interpretation. This is an essential component of the "human experience" and a theme that runs through this book. Many scientific conventions, norms, attitudes, and scientific culture are themselves significant barriers to the more effective use of science in decision-making (Rofougaran and Karl 2005). Many scientists balk at directly involving people in shaping or reviewing research because the scientist is the expert and the people are, well, not the experts. What could they possibly contribute?

Many scientists also discount the knowledge of local residents and indigenous people as anecdotal. There is a vast scholarly and practitioner literature on this topic (e.g., Fisher 2000; Wondolleck and Yaffee 2000; Adler and Birkoff 2002; McKinney and Harmon 2004) as there is on the relationship of science to society (Gibbons et al. 1994; Klein et al. 2001; Nowotny et al. 2001; Pielke 2007; in't Veld 2010; many publications by Jasanoff[3]). The concepts in much of the science, technology and society literature are complex, by-and-large esoteric, and need to be refined to simple actionable items to be practicable. We are not going to repeat the arguments in the academic literature on this topic except to emphasize a point here and there. Rather, we examine these topics and others through the lens of experience and practice.

We do not advocate that all scientific research be conducted as part of a collaborative process; that, of course, is not only impracticable but also unnecessary and undesirable (see Chap. 10). Nor do we suggest that all scientific investigations should be interdisciplinary. Single discipline science brings focused research through which fundamental advances are made in any one field or discipline. However, "wicked" problem solving generally requires interdisciplinary and multidisciplinary research and the collaboration of scientists with citizens. Such problem solving requires that some scientists participate actively with collaborative groups and that some scientists engage in interdisciplinary research. In our experience, however, the balance (and the preference of most scientists) is strongly weighted in favor of single-discipline and non-participatory (with lay people) research. We believe the balance needs to shift in order for science to be better integrated into policy formulation and management implementation, especially when dealing with wicked problems.

[3] Shelia Jasanoff, Pforzheimer Professor of Science and Technology Studies, Harvard Kennedy School.

Why hasn't the balance shifted? The call for interdisciplinary research is not new.[4] And it has amplified in proportion to the increasing complexity and contentiousness of our environmental problems.[5] It is important to understand the relationship of science to society that evolved after World War II to assess the current situation and determine how we should proceed from here. We do not intend a nuanced and complex analysis of the post-WWII history of science nor why scientists do or do not ascribe to certain practices. Again, many academic tomes (including historical, behavioral, sociological, political, and psychological) dissect these topics and are available to the inquiring reader. Rather, we highlight those elements, distilled by our diverse experiences as scientists and policymakers, which are important.

There are six principal barriers:

- Scientist as expert
- Personality
- Reward structure
- Barriers among disciplines
- Paucity of funding for interdisciplinary research
- Risk adverse leaders
- Mistrust of local and indigenous knowledge

Vannevar Bush's report, *Science: The Endless Frontier* (1945), published after the Second World War, had a singular impact on the direction and role of science, technology, and engineering in America through at least the 1960s. Its legacy continues to the present, although it is rarely cited anymore or even known by the younger generation of scientists. This report essentially established the National Science Foundation. It expanded the large-scale scientific and technological efforts started during the war when science was done at a scale that dwarfed earlier efforts. "Big" science became the norm in academia, government, and the private sector in the post-war years and resulted in two principal outcomes: (1) enormous benefits to society by improving the quality of life in many sectors and (2) establishing scientists as a special class of experts apart from the rest of society. Both of these outcomes have unintended consequences, and it is the latter that we focus on.

Scientists (we use this term to include technologists and engineers) ascended to a pedestal. They were consulted by other classes of society as oracles and seers of the future – as wise kings.[6] The consequence of this deference is that scientists

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[4] Interdisciplinary research to us includes the combination and integration of biophysical science, social science, political science, and engineering applied to problem solving, environmental policy formulation, natural resource management, and planning. But in general usage "science" means physical science – the so-called hard sciences – and it is by this definition that we discuss science in this section.

[5] Papers published 30 and 40 years ago make this same statement.

[6] We would suggest there is a wide chasm between being wise and smart. Scientists are often wrong, perhaps, more often than they are right; this is how science advances. Wisdom is rare and is never easy to attain. However, it might be more likely to be attained through a collective process that involves many diverse voices than by a monolithic block of few ideological voices (see Surowiecki 2004, The Wisdom of Crowds). The same might be said of actions shaped solely by

disproportionately directed the future of society, identifying priorities and directing investments toward those priorities rather than participating with others in debating and deciding the future. This relationship, although weakened, holds today in setting science agendas. We do not generalize to all of science in the discussion that follows. We are speaking specifically about the role of science and scientists for restoring and sustaining lands. To reinforce that point, it is worthwhile to restate two passages in Chaps. 1 and 10.

> 'We end,' Leopold concluded, 'at what might be called the paradox of the twentieth century: our tools are better than we are, and grow better and faster than we do. They suffice to crack the atom, to command the tides. But they do not suffice for the oldest task in human history: to live on a piece of land without spoiling it.'
>
> All need to acknowledge that when it comes to understanding the behavior of complex social-ecological systems, no one (and everyone) is an expert. All participants bring useful knowledge and experience to the table, whether it is scientific, technical, traditional, cultural, local or remembered, and every type of knowledge has standards of quality that can be examined, debated or shaped.

In the twenty-first century, we hope to move beyond the paradox of the twentieth century by developing a process that supports the second statement above and, thereby, enables us to "live on a piece of land without spoiling it." Restoring lands is different from sending a rocket to the moon. Therefore, the process to accomplish these different tasks ought to be different. Both applications require a team effort. However, the former requires a holistic, collaborative process that includes diverse participants beyond that of a team of scientists, technicians, and engineers. With respect to restoring and sustaining lands: A well-designed and implemented adaptive co-management process will improve the capacity of all participants to learn from different kinds of knowledge. Building the capacity of scientists to participate in this process and building the institutions to support it present big challenges that we discuss in following sections. First, we consider a few reasons why this institution building and decision-process evolution is challenging in the case of scientists.

Most scientists choose science as a career because they are curious about natural phenomena; it is what they like to do and part of their personality. It follows that few scientists will want to engage in a multi-stakeholder deliberative process, and certainly not an ongoing process that could take months and years. Some, however, do want to engage in these processes (authors of this book are among them). Yet scientists in academia and federal science agencies are rewarded for the quality of their work as evaluated principally by publications. Junior faculty must establish themselves as among the elite in their discipline and field or they will not make tenure. Federal agency scientists in the research grade evaluation category face the same

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those with technical and scientific knowledge. Such actions may reflect knowledge of the physical properties and system dynamics of ecosystems, but they may not represent outcomes that reflect the multiple values of those affected by resource and land management choices nor practices that embody the experiential knowledge of those living on these lands and in their surrounding communities.

challenge for promotion.[7] Tenure and promotion panels evaluate other elements of a scientist's performance (e.g., teaching, service on committees and advisory panels, and leadership), but without a strong publication record, promotion is very unlikely. It is very difficult to have an interdisciplinary paper (especially if the disciplines involve a combination or integration of physical science and social science) accepted for publication. So, most scientists focus individually on research within a single discipline or collaboratively with closely related sub-disciplines (e.g., geology, geophysics, and paleontology as sub-disciplines of earth science). The stove piping of academic departments and government research groups reinforces single discipline research. These barriers can be broken but usually by the efforts of individuals who want to work together and not because there is an easy institutional process.[8]

A major obstacle for conducting interdisciplinary research is the paucity of funding for such research. The National Science Foundation and other foundations have established some programs to fund interdisciplinary research, but the amount of money available is insignificant when compared to disciplinary programs. Line-funded programs in most government science agencies are by discipline or theme (e.g., biological resources, climate change). The U.S. Geological Survey is an example of an agency that encourages proposals for programmatic funding to include personnel from one or more USGS disciplines. This is a step forward to effect interdisciplinary research in a federal science agency.[9] Yet, there is no organizational unit within USGS structured to function as an interdisciplinary research unit.[10] Generally, the science programs or funding opportunities in USGS do not specifically require collaborative processes approaches as a condition for funding.

[7] A number of USGS scientists early in their careers have told Herman Karl that they would like to do the research he is doing on the role of science in collaborative processes, but know they would not get promoted. Indeed, when Karl shifted his career focus toward this research, his promotions were slowed because he was no longer publishing in the conventional journals of his discipline (marine geology). During one promotion cycle, a friend on the evaluation panel told him that his colleagues on the panel thought "you [Karl] had gone crazy because you are working with an economist" and publishing in ocean management journals. For Karl to continue to do so meant that he would not be promotable; he eventually transferred to another division where he was encouraged to continue his research.

[8] Leadership of both academic and governmental institutions may dispute this characterization. It is based on the experience of some of the authors. And all one needs to do is to ask scientists in the field and laboratories how easy it is to break down the barriers to interdisciplinary research within their organizations. We acknowledge that some progress has been made to encourage interdisciplinary research. But the very fact that publication after publication continues to assert the need for interdisciplinary research argues that it still is not routine. The few exceptions do not invalidate the assertion that interdisciplinary research is not common nor facilitated by most academic and governmental institutions.

[9] Karl was a member of the USGS Strategic Planning Team in 1994 and 1995. At that time USGS had about 30 programs distributed among three divisions (Geologic, Water Resources, and National Mapping) The team interviewed each program coordinator and learned that none of them had talked to one another; in other words there was no communication or coordination among programs. Yet, even at that time USGS considered itself an integrated science agency. Since then USGS has undergone several reorganizations.

[10] This statement is based on Karl's 33-year career with USGS; he and many other USGS colleagues will argue that there is no easy way to conduct interdisciplinary research within USGS.

Before USGS ended its participation in the MIT-USGS Science Impact Collaborative program with MIT, it had discussed initiating a competition in which scientists could submit proposals to have a science-impact program intern attached to scientists' projects to explore the appropriateness of collaborative processes for these projects. Chapter 7 describes an innovative competitive proposal review process that requires a substantive collaborative process (not to be conflated with outreach) as the framework for conducting research. This process is part of the Science Collaborative program of the National Oceanic and Atmospheric Administration's (NOAA) National Estuarine Research Reserve System (NERRS) administered by the University of New Hampshire. The requirement has significantly influenced the content of the proposals submitted to the program. Karl served on the first review panel when this process was initiated.

The collaborative process approaches described in the proposals were weak and unsophisticated. Karl later served on the panel reviewing proposals in the third year of the program. The collaborative process section in many of the proposals was very well thought out and included experts and practitioners in the field as part of the research team. The earlier proposals had referenced the collaborative process section but did not include substantive collaborative elements. This experience suggests that if foundations and agencies require a collaborative process approach for proposals to be considered for funding (and include persons on the review panels that are knowledgeable in these approaches), scientists will respond and collaborative, interdisciplinary research will become more common.

The innovation of the NERRS Science Collaborative program is an example of leaders willing to take a risk to foster change. Individuals in leadership positions can impede innovation, maintaining the *status quo*, if they are risk adverse. Yet being bound by convention diminishes creativity and imagination and can foster mediocrity. Cutting-edge research is research into the unknown, and much of it is bound to fail; failure should be expected. The key to future success is learning from past failure and applying the lessons to make ongoing corrections. Failure needs to be seen as part of a constructive learning process for achieving excellence and not a destructive force to be feared. Visionary and risk tolerant leadership can provide the "space" for innovation and the "safe harbor" for creativity. Such leadership can foster a culture of critical thinking and open mindedness that enables change. Fostering such leadership is a hallmark of superior institutions.

The sixth barrier is the conflict between expert and local knowledge. The term local knowledge covers a broad spectrum of different kinds of knowledge. Some use the term in reference to local "lore," including indigenous knowledge. People that have lived on the land and with nature for generations have developed a special relationship with and knowledge of the land and sea. Indigenous peoples that practice a form of subsistence living are attuned to the rhythms of nature, seasonal weather variations, timing of plant flowering, some animal behavior, and many other observations. But local knowledge also refers to what Nobel laureate economist F.A. Hayek referred to as experiential knowledge. This sort of knowledge includes, for example, the practical knowledge gained through practicing a profession such as farming, or logging, or fishing. The knowledge that resides in these people – farmers, ranchers, fishers, and indigenous peoples – has value. Such knowledge, for example, can help to identify ways of reshaping practices to reduce environmental impacts while still sustaining work opportunities.

Many scientists, however, discount local and indigenous knowledge as only anecdotal, particularly in reference to observations about biological and physical phenomena, because such knowledge has not been acquired through the scientific method of hypothesis testing. They are right to question this knowledge. For example, some local observations may have too narrow a geographic compass to detect larger trends. In the last decade, in one instance some indigenous populations near the Arctic began observing larger than usual numbers of polar bears on land and attributed these sightings to an expanding population. Closer scientific research indicated that bear populations were not increasing; rather, due to sea ice melt, bears were spending more time on land, giving local residents an impression of bear population increases. This example is illuminating. The indigenous people's observations were, in fact, accurate – more bears were spending more time on land. Those observations helped stimulate further scientific inquiry that resulted in an understanding of what was happening to the overall bear population in the area.

But these concerns about local knowledge, in many ways, misunderstand the broader relevance of such knowledge, particularly of the sort of experiential knowledge described by Hayek. Not all knowledge relevant to environmental problem solving is scientific knowledge. Often, problem solving also requires practical knowledge about farming, fishing, and other professions. For example, when Alaska biologists determined that some albatross populations were declining as the birds were entrapped in fishing gear, the biologists informed the fishing community. That community, having the situation explained to them, used their practical knowledge of their gear and practices to come up with alternatives that enabled them to continue to fish while no longer harming the birds. This sort of knowledge is highly relevant to figuring out ways to lighten the environmental impacts of human action – but it is the sort of knowledge gained through experience, practice, and familiarity with place and circumstance.

All forms of knowledge, whatever the source, ought to be questioned and challenged. But the questioning should be respectful of the legitimacy of the ways in which the knowledge was attained and how it is used. Some scientists, however, do not acknowledge the legitimacy of or understand the relevance of other forms of knowledge. Ranchers, farmers, and fishers utilize the results and products of science and technology to complement their experiential understanding of the lands and seas where they live and work to improve their wellbeing Our ability to restore and sustain lands for the wellbeing of all of society can be diminished when participants in these efforts fail to utilize the knowledge of local peoples that has been vetted through respectful questioning and assessed for its potential to reveal both constraints and opportunities for constructive action.

2.2 Governance

Throughout this book, we have described people, through communities, agencies, and organizations, joining together to manage natural resources across land ownerships and jurisdictions. Increasingly, such efforts are moving beyond specific actions taken at a single point in time to becoming enduring collaborative initiatives. Such efforts require coordination to establish goals, evaluate, select, and fund actions, and assess outcomes. In short, these efforts require methods of governance – the rules and structures through which actions are coordinated, responsibilities are defined, and accountability is achieved. They require institutions and decision processes that facilitate coordination across jurisdictional boundaries and among public and private sector participants. These collaborative efforts often require both horizontal and vertical interaction among multiple pre-existing governing units. Such intergovernmental interactions are not new. Indeed, in the United States, the entire governing framework is one of federalism, which implies some sharing of public decision-making and a vertical distribution of governing roles and responsibilities. Also, in the United States and elsewhere, we have many examples of regional governance.[11]

But these forms of federalism and regional decision making require a different character to respond effectively to the challenges presented by collaborative conservation – challenges that not only cut across geographic jurisdictions but often require a multi-issue, ecosystem-based framework for effective action. Kirk Emerson describes "collaborative federalism," in which joint decision-making occurs among multiple governing units. The model she describes is one of "shared governance," not divided and distributed decision-making.[12]

But collaborative federalism presents challenges. How might one convene and motivate a cross-jurisdictional polity? And policy makers face practical challenges associated with limits on their authorities to expend funds outside jurisdictional boundaries. Yet such expenditures may be important. Consider source water protection in which relevant lands may lie outside a city's boundaries. Or consider the need to sustain cool instream water temperatures along an entire watershed. Or consider beach replenishment along coasts, in which sediment deposition may be required outside a city's boundaries to secure the desired protections.

Two challenges of multi-jurisdictional governance are particularly relevant for collaborative conservation. Fundamentally, policy makers face the challenge of how to achieve a decision scale "big enough to surround the problem, but small enough to tailor the solution."[13] Second, policy makers face a challenge of how to share both goal setting and financing across governing units.

Cross-boundary governance options include both structural and non-structural tools.[14] Structural tools include the creation of dedicated agencies, special districts, and institutions, such as water management districts that combine responsibilities for managing drinking water, stormwater, and wastewater. Nonstructural tools include service agreements, partnerships, joint programs, and other informal coordinating arrangements. Both may be relevant in the context of collaborative conservation, depending on the particular issues and community circumstances.

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[11] *Regionalism on Purpose*, Kathryn A. Foster, Lincoln Institute of Land Policy, Cambridge, MA, 2001.

[12] "Collaborative Public Management and Climate Change: Managing Climate Change in a Multi-level Governance System," draft chapter, January 2010, for *Climate Change and Federalism*, forthcoming.

[13] *Regionalism on Purpose,* op. cit., p. 4.

[14] Ibid., p. 8.

In the United States, we see many emergent models. In southeastern Wisconsin, 28 municipalities with separate stormwater management authorities have joined in a public-private partnership to create a trust to coordinate stormwater management in an area encompassing six watersheds.[15] In the Tualatin Basin, water managers combined four wastewater permits and one stormwater permit into a single cluster and partnered with the farmers in the county and the U.S. Department of Agriculture to plant trees within the watershed to reduce water temperatures. Both of these partnerships are issue specific. Very few U.S. examples present models of multi-purpose, cross-jurisdictional government.

Though few such examples exist, over the past 15 years, governments – federal, state, and local – have increasingly articulated the need for greater interagency coordination and shared action. Agencies point to the need to break down "silos" in which interconnected issues have been addressed through segmented agency responsibilities and fragmented actions. The Bush Administration, eying the silos, established a Cooperative Conservation Task Force and convened a White House Conference on Cooperative Conservation. Much of the focus of the Task Force was on how to secure better interagency partnering and greater agency collaboration with the public in addressing natural resource issues. The Obama Administration, using different terminology, also acknowledged, through a presidential Executive Order and a focus on landscape-scale conservation, the relevance of more coordinated, interagency governance and action.

But such coordination is not easy for a variety of reasons. In many instances, statutes segregate responsibilities among different agencies both by geography and policy issue. Other statutes prohibit pooling of funds from multiple agencies. Even simple matters such as use of different IT and communications systems can impede coordination and collaboration among agencies. These and other technical details can be overcome, but transcending these problems requires persistence and time.

Cooperative agreements among agencies are common, but they often define and distribute responsibilities rather than blend them for shared management. For example, upon creation of the Papahanaumokuakea Marine National Monument under provisions of the 1906 Antiquities Act, the President designated the U.S. Fish and Wildlife Service and the National Ocean and Atmospheric Administration as co-lead managers, which required joint development of a single management plan. The process was a difficult one, as each agency had somewhat different planning procedures, goals, and authorizing statutes under which they operated. Without the directive of the President of the United States, it is not clear that the agencies, self-motivated, could have created (and implemented) a co-management plan.

Achieving collaboration among agencies is difficult, but even more difficult is developing governance mechanisms that include public, nongovernmental, and private participants. Yet such arrangements may be helpful where collaborative conservation

[15] "Green, Clean, and Dollar Smart: Ecosystem Restoration in Cities and Countryside," Lynn Scarlett, forthcoming, Environmental Defense Fund, Washington, D.C.

includes both public and private lands in which their managers and owners are pursuing shared goals. At the Federal level, at least one statute explicitly constrains public managers from engaging in policy discussions with non-governmental persons unless a specially chartered federal advisory committee is established.

However, various institutional and land management governance options are emerging in various locations across the Nation as public and private organizations increasingly operate at landscape scales, across multiple jurisdictions, and with public, private and nonprofit participation. Several examples illustrate models of network (sometimes referred to as "shared") governance.

The Congress established the Valles Caldera National Preserve in 2000 to maintain the 88,000-acre caldera as a working landscape and perpetuate a multiple-use policy in the preserve. To meet these goals, the Congress established the Valles Caldera Trust, a wholly owned government corporation governed by a nine-member board of trustees who serve 4-year terms and may serve up to 8 consecutive years. The Board includes seven members selected by the President and two members representing the Santa Fe National Forest and Bandelier National Monument. The Board has full authority to make all decisions concerning the use and conservation of the Preserve. Public input is provided through the planning process, open board meetings, and volunteer participation in the stewardship of the Preserve. An Executive Director and a staff of 25 manage and carry out activities.

The Board develops strategies and specific actions with accompanying outcome-based performance measures and timelines. The Board has a set of management principles that include coordinating with adjacent landowners to achieve a healthy regional ecosystem through science-based adaptive management that informs management decision-making on the Preserve. The Preserve receives some federal funding but also receives financial support from other sources. The Trust uses cooperative agreements with the federal agencies to carry out joint actions, as needed.

Also in the southwest, citizens, local governments, and conservation groups concerned over the health of Las Cienegas Creek Watershed thought restoration must include state trust and private lands, along with federal public lands. These participants formed the Sonoita Valley Planning Partnership and joined with the BLM to create, through federal legislation, the Las Cienegas National Conservation Area (NCA). The partnership created a community-based management plan that was eventually adopted by the BLM as the preferred alternative in the Las Cienegas conservation area's planning document. The partnership works with the BLM to implement the plan through a collaborative adaptive management process. The Las Cienegas NCA is the first major BLM-administered land area to simultaneously engage community-based planning and community-based implementation of the adaptive management plan.

These pioneering efforts in collaborative governance that include both public and private sector participants may offer models for future collaborative conservation initiatives. However, their formation is too recent to assess their long-term durability. Moreover, most of the major large landscape national conservation and restoration projects are not structured as ventures in network governance. The Chesapeake Bay restoration effort, Everglades Restoration, the Bay-Delta initiative in California, and

Louisiana Gulf Coast restoration all involve multiple agencies – federal, state, and local – through various task forces, working groups, and planning processes. Nongovernmental participants generally do not have decision-making roles. Rather, their roles conform to more traditional public review and commentary on goals and plans.

2.3 People and Action[16]

Why have so many grassroots collaborative groups formed to restore lands and protect ecosystems independently of government agencies charged with this mission?[17] Many academic analyses and interpretations address this question. We encourage the reader to explore these assessments. (Excellent starting points and citations to more specialist literature include Wondolleck and Yaffee 2000; Webber 2003; Koontz and others 2004; Brunner et al. 2005).

One citizen practitioner offers the controversial observation that federal agencies have become irrelevant, thus giving rise to local collaborative action.[18] At the same time, other observers – within agencies and among the public – believe collaborative groups are cumbersome, time-consuming, and ineffective. What these perceptions share is a growing frustration with the continuing deterioration of ecosystems and economies (livelihoods) dependent on these systems. Frustrations among both citizens and agencies result from the polarized political disputes that result in deadlock and/or insufficient management practices.

There are, of course, other reasons for the growth of these groups. For example, many natural resource issues have a fundamentally local dimension that arouses local passions, attracts grassroots interest, and requires on-the-ground knowledge of both lands and human communities associated with those lands. In some cases, shared concerns have spawned shared responses through collaborative action. In other cases, impatience with perpetual conflict has galvanized dialogue to transcend these conflicts. But, regardless of the formative motivations for the creation of these efforts, many collaborative endeavors reflect a perception that traditional institutions and rules have failed to advance sustainable land management solutions.

Many natural resource and environmental institutions and laws were established in very different periods of American history, often with different demands and values than exist today. These institutions and laws have several features that often fit poorly with current circumstances. First, authorities are fragmented by issue and, sometimes, geography, making integrated, ecosystem-based decision-making difficult. Second, many statutes and associated rules prescribe specific technologies or

[16] This section was influenced and benefitted by discussions with Gary McVicker and Richard Whitely.

[17] These are a genre of civil society organizations (CSO).

[18] Will Hopkins, director of the Cobscook Bay Resource Center, made this statement July 2010 at a retreat in Maine to discuss the role of collaborative groups in resource management and ecosystem restoration.

practices, thus limiting flexibility to respond adaptively to dynamic circumstances. Third, procedures for public engagement are rule-bound and formal, limiting possibilities for robust dialogue and grassroots participation in decisions.

At a time when more integrated, ecosystem-based management may better fit the realities of complex, interconnected issues and challenges, these institutions with fragmented authorities may actually deepen divisions, particularly when issues are layered with political rhetoric that hardens perspectives and limits the ability to search for a confluence of goals and values. At the same time, hierarchical systems are ill designed to support collaboration, either among institutions or with citizens.

Despite these institutional challenges, many public-sector pioneers are striving for more effective collaboration, in spite of obstacles facing them inside and outside government. Their success will almost certainly remain limited without a fuller understanding of collaboration and a greater commitment from within the established systems of government to support collaborative efforts. Collaborative, citizen/community-based ecological stewardship does require a rethinking of public-sector roles.

Collaboration is a two-way road, and both citizen groups and agencies put up barriers along the way. Generally, these barriers do not arise maliciously. Rather they result from the assumption of long-standing roles and authorities by government agents, defensiveness against that authority by some citizens, and communications challenges among people holding diverse priorities and different experiences. Roadblocks exist among citizenry and among agencies and other institutions. Barriers extend in all directions, and at all levels of society and government. Yet potential players often may desire the same broad goal – harmony among ecological, social, and economic systems.

Some decision-making institutions and processes have served to pull people apart rather than bring them together, thus increasing mistrust. Yet, with proper nurturing, trust can develop and relationships grow that evolve into collaborative action. Through those relationships and conversations, participants are often able to transcend differences in worldviews, philosophies, backgrounds, and roles to find some shared values and goals pertaining to management of lands and resources within their communities.

Conversations, an important starting point, should, however, not be confused with collaboration. Through conversations, barriers are lowered and trust increases upward in the agencies and outward in the social networks. The result can be robust collaboration, a shared sense of responsibility mobilized to accomplish specific common goals. Conversation creates dialogue. Collaboration builds upon conversation to create action.

Whereas collaborative action holds promise, some critics dispute the effectiveness of collaborative process approaches among citizens and agencies for managing ecosystems (Peterson et al. 2004; Layzer 2008) and of collaborative processes for regulatory policy development (Coglianese 2001). Collaboration is not a panacea, nor is it suited to all circumstances. Some collaborative efforts have dissolved without achieving consensus or action. However, to understand the potential of collaboration, distinctions regarding different kinds of multi-participant interactions are important.

With respect to ecosystem-based management, some cases called collaborative processes are actually attempts at coordination among agencies (the Everglades restoration, in particular, is a case in point). They do not involve multiple stakeholders in goal setting, decision-making, and action implementation. Efforts at coordination to transcend jurisdictional and issue boundaries among agencies are both necessary and important for large-scale restoration projects. However, as discussed in Chaps. 1 and 9, such cases of coordination should not be confused with grassroots collaboration. Thus, evaluation of their effectiveness has little relevance to understanding and evaluating collaborative processes. Various chapters in this book have shown that these collaborative processes can sometimes (possibly often) achieve the productive harmony discussed in Chap. 1. But their success depends on well-structured decision processes, clear goals and long-term strategies implemented in a step-wise process, monitoring of outcomes, and assignment of accountability for results.

Why are robust collaborative approaches between citizen groups and government agencies uncommon? One might argue that they are not uncommon because there are hundreds of collaborative groups around the nation. A large number of these groups assembled at a White House Conference on Cooperative Conservation held in St. Louis, August 2005.[19] Yet a cursory examination of these groups shows that only some have active collaboration with federal government agencies (we limit our discussion to federal agencies, although some of our observations and comments with regard to barriers could be generalized to state agencies). Such public-private collaboration that extends to goal setting and decision-making remains relatively uncommon. Few collaborative efforts reflect, for example, the type of relationship that the Tomales Bay Watershed Council has with government agencies as described in Chap. 20. Yet it is this sort of shared governance that holds promise for governing and managing ecosystems across jurisdictional boundaries and involving public and private participants who manage intersecting resources.

Six principal barriers inhibit emergence of collaborative, shared governance models. These include:

- Limited understanding of collaborative structures and processes
- Risk aversion that results in support for the status quo
- Challenges of linking formal systems and informal decision making systems
- Funding
- Questions of legitimacy
- Accountability/ways to measure success
- Defining the appropriate decision boundaries

There are a number of examples of federal agencies moving toward collaborative approaches with citizens. These include the National Oceanic and Atmospheric Administration's Regional Integrated Sciences and Assessments (RISA) program. The program supports "place-based research and innovative *outreach activities*" (emphasis added) and programs in the U.S. Forest Service to name but two. Though

[19] http://cooperativeconservation.gov/conference805home.html

these efforts are important vehicles for public-private communication, few of these programs are collaborative processes in which citizens participate as equals. Outreach is not a collaborative process – it is an education process to inform.

The agencies are not alone in conflating outreach with collaborative processes. Many citizens (and some academics as well) also do not understand them. Many of us think we know how to collaborate. Herman Karl, co-editor of this book, was one. He discovered, however, that there is a field of collaborative processes and consensus building with established best practices and procedures. During his tenure at the U.S. Geological Survey, he was told many times in conversations with colleagues in federal agencies, "We are already doing what you are talking about." He then would ask, "Tell me what you are doing?" Invariably, what they described as collaborative processes was simply a meeting among agency personnel and stakeholders with no ground rules and none of the characteristics of a well-designed collaborative process.

Often consultative processes and public commentary on agency actions are confused with participatory processes. By and large, agencies invite comments by citizens on decisions already made or plans already written but with no guarantee that their comments will be incorporated into the final decision or plan – an no upfront engagement in crafting the original concepts and goals. This consulting process has been called the "Three-'I' Model" – "inform, invite, and ignore" (Daniels and Walker 2001, 9). It is far different than having worked with citizens as part of a collaborative group to develop the plan jointly or to consider the decision together. Agencies either conflate this comment process with a participatory collaborative process or they simply do not want to share power with citizens; many citizens often feel that it is the latter.

Often, agencies also think of collaboration as a process of interagency dialogue and coordination. Such efforts often do not involve collaborations with citizen groups. Now is a good time for readers to refresh their memories and refer to the discussion of collaborative processes in Chap. 1. Overcoming the misunderstanding and inertia in agencies and communities to maintain the *status quo* is a significant barrier.

The structural framework of the *status quo* is the formal hierarchy and procedures within agencies. Bureaucratic rules, checks and balances can impede flexibility and nimbleness in adapting to changing circumstances and tailoring procedures and decisions to the specific situation. Performance standards and incentives strongly reinforce the *status quo*, as do budget priorities and other constraints imposed for political reasons. Yet it is entirely possible for government to function more collaboratively, while adhering to the standards and ethics used to define good governance in the past. The Internet, for example, opens up possibilities for openness, inclusiveness, and citizen participation as never before possible. But if citizen/community-based ecological stewardship is to be served, its use should be aimed at empowering that process – locally! Oversight and involvement by the larger society it is important, especially where transcendent national values are involved. Often, however, collaborative efforts involve management decisions about local ecosystems and their components that have few or no implications for a broad national constituency. In these many instances, broad social and national oversight may be most useful as a means of strengthening the capacity for collaboration, and empowering locals in consensus building, finding solutions, and taking actions. The process should help build trust across society.

Perhaps it is time to ask several key questions: Are those tenets of empowerment respected within government itself these days, and might citizens help to restore them? Furthermore, might it be possible for collaborative efforts to contribute to the emergence of less costly government through their potential to leverage resources, function more nimbly than public agencies, and adjust more rapidly to changing circumstances? Collaboration demands that power be shared in a fully responsible manner, functioning with appropriate constraints and the adherence to governing principles, but enhancing shared decision making nonetheless. Collaboration should improve the tenets of good governance, not abandon them.

The internal design and function of government, examined in the context of collaborative stewardship, are, to a large degree, upside down from what is often needed. Can a system designed to move power upwards serve a process that demands it be moved outwards and downwards? Furthermore, many policies and other constraints now limit consideration and application of potential solutions that might otherwise be considered though a locally empowered process of collaborative stewardship. If agency cultures are to evolve that transform and overcome these obstacles, experimentation should be encouraged. Internal oversight by the Congress, the Government Accountability Office, and agencies themselves will have to support that experimentation and may require development of new parameters and standards against which to measure performance. Experimentation needs to include all sectors of government and situate within government processes that seek and support citizen/community-based solutions.

One concern about collaboration is that of potentially asymmetric power between, for example, industry participants and local environmental, social and community groups. The potential for this asymmetry leads to concerns of co-optation in which economic interests outweigh other values and interests.

A related concern is that agencies will become co-opted by local interests, thus losing sight of their broader regional and national responsibilities. This concern presents a two-way balancing act in which, on the one hand, federal agents engage with communities while fulfilling their broader responsibilities. The pursuit of collaboration does not mean that regulation and laws no longer apply. On the other hand, community participants need to express their local interests to agency personnel, including their critiques of agency mandates while not ostracizing them if they think agencies are not fully responding to their interests.

Many grass roots movements arise from and are spread through informal system networks (Chap. 19). The formal and informal systems often come into conflict. However, much headway could be achieved if these systems would learn to work in creative tension, rather than with resistance. Both communities and agencies need to be receptive to change and respect and recognize as legitimate each other's point of view and responsibilities (see Chaps. 17 and 18). As described in Chap. 1, there are situations in which collaborative processes are not appropriate and will not work. Citizens and agency personnel need to understand this. Trying to force collaboration is counterproductive.

In 2003, the Bush Administration created an Interagency Cooperative Conservation Team to identify ways to enhance collaboration. The Team heard one action repeatedly stated from a number of collaborative groups: do not transfer local personnel "every two years." Whether 2 years or ten, it seemed to them that just at the time agency personnel have established a relationship with the community, they are transferred to another location. If the frequency of transfers cannot be reduced, a process for making sure there is a significant overlap between the outgoing and incoming people should be assured. A simple process through which the outgoing person introduces the incoming person to the community might suffice. Participants also identified openness to different perspectives as critical to success of collaborative efforts. Newcomers to collaborative processes benefit from embracing an attitude of, "What can I contribute?" not, "I am here to do things my way." For some agencies, such a perspective is unfamiliar to federal agents, many of whom were trained to establish management goals and apply rules and regulations. They were not trained in mediation, facilitation, and negotiation. These professional attributes suggest that, in some cases, agencies may even need to recruit personnel with different skill sets.

All citizen collaborative groups struggle for funding. Obviously, lack of money limits their effectiveness. The funding they do obtain is usually short term, available for 1–3 years for operating expenses and, perhaps, for a small restoration project. For these groups to function as viable stewards of ecosystems, they need a regular source of long-term funding. Effective and prompt follow-up on the part of agencies is critical to building trust. Many agency personnel involved in collaborative stewardship must fund their efforts by competing for private grant monies.

With limited budgets, choices need to be made. The choice too often is to maintain the *status quo allocation of funds for agency projects rather than toward collaborative processes and actions*. Allocation of human resources can also present challenges. For many public officials, working with collaborative groups is considered outside of the normal job, especially for research scientists. Agency personnel are overwhelmed by their "standard" duties and taking on more tasks is often not possible. Until human and financial resources are allocated towards collaboration with citizens, such efforts will be sporadic.

Legitimacy and accountability are related. In order for citizen collaborative groups to be accepted as legitimate and credible they must be held accountable to certain standards. A vast literature in the academic, government, and business sectors discuss forms and measures of accountability. One book that discusses grassroots movements for managing ecosystems devotes four (160 pages) out of eight chapters to forms of accountability (Webber 2003). Another book on collaborative approaches to natural resource management addresses accountability in one chapter (16 pages) (Wondolleck and Yaffee 2000).

Accountability in the context of collaborative conservation involves at least three different kinds of outcomes. These include: (1) ecosystem outcomes, which pertain to whether on-the-ground actions result in the ecosystem goals articulated through the collaborative process; (2) process/governance accountability, which involves examining whether a particular collaborative effort is inclusive, engenders participation in the shaping of goals, and provides means for holding participants responsible for achieving stated goals; (3) "values" outcomes, which refer to whether the collaborative effort fulfills the multiple value sets (economic opportunity, ecosystem restoration, recreation, etc.) All three of these dimensions of accountability are important as they pertain to three linked and relevant components of sustainable restoration and conservation.

Selection of metrics to measure ecosystem outcomes is difficult. On the one hand, many scientists strive for detail and metrics refinement; on the other hand, such detail is seldom “manageable” as a sort of dashboard indicator to signal needed course corrections to managers and the public. Many metrics are really proxies rather than direct measures of hoped for outcomes, but sometimes proxies are more useful from a management perspective than are detailed, direct measures. Measures can also sometimes be both misleading and counterproductive if they are so unidimensional that they result in missing potential trade offs (near or long term).

When the Interagency Team asked the Okefenokee National Wildlife Refuge citizen collaborative group how they measured success, members of the group smiled at each other and said, “Just look around at this wonderful place, it wasn’t like that 10 years ago.” Of course, there should be a more rigorous measure of accountability and success than the aesthetic, even if that aesthetic is used as a proxy for a healthy ecosystem. In some ways, the Okefenokee commentary highlights the intersection of ecosystem outcomes and values outcomes. For Everglades Restoration, for example, specifying and measuring outcomes involves scientific observations. But behind those ecosystem measures lie values, preferences, and assumptions – assumptions about just what condition Everglades Restoration advocates hope to achieve. Is it the condition of the landscape as it was in 1880, 1930, 1950, or something else? Thinking about that condition invokes questions that pertain to community values, physical realities, technical feasibility, and resource availability.

These questions of values, in turn, underscore the relevance of governance structures and collaborative processes. Whose values are expressed? Are all stakeholders at the table? How are decisions among different value sets and priorities made? Are these processes viewed as legitimate? These questions highlight the importance of measures of accountability pertaining to the governing processes themselves.

Developing measures of accountability for the governance structures and values outcomes present numerous challenges, as they involve, in part, qualitative and process issues. Every collaborative group with whom we have talked has emphasized the value they put on the place they live; although they may have different reasons, they want to preserve the qualities of that place. Indeed, when residents discover they often share a common vision for the land, it opens the door to constructive and productive conversations. Although there is wide agreement throughout the academic and practitioner literature that “place” is an important element, few studies take into account how people actually relate and identify with their landscapes, reflecting the natural boundaries within which people communicate and take care of each other (Chap. 19).

These cultural boundaries and settlement patterns most often do not mirror political boundaries. In Chap. 1 we described the importance of a stakeholder assessment for determining if a collaborative process approach is warranted. Consideration of a collaborative process approach to ecosystem-based management requires much more preparatory work. It requires mapping of social processes (Clark 2002) and human geographic mapping (Chap. 19). Ecosystems and watersheds spread across multiple jurisdictions. But these jurisdictional boundaries are, for the most part, political boundaries having little or no relation to geographic and physical boundaries, settlement patterns, and cultural boundaries. In recognition of the impact of geography on social processes, John Wesley Powell, the second Director of the U.S. Geological Survey, recommended that the main unit of government in the arid lands of the west be "hydrographic basins" that would cross state lines as necessary. The land would be in the public domain and each landowner in a "natural district" would have a share of the common water (Worster 2001, 494–495). He thought that these districts would help mitigate conflict over water rights. A process that takes into account cultural boundaries and social norms and values could lower barriers to collaboration and help achieve more effective ecosystem-based management. But assessing such processes and measuring their effectiveness in terms of the ecosystem outcomes they produce, their governance functionality, and perceived legitimacy as decision processes involve developing metrics that are simple and meaningful, normative and objective, procedural and physical.

We now endeavor to develop all that we have written up to this point into a coherent whole. We do not intend to summarize, but to synthesize a new approach composed of the elements that comprise this book and that can be found in a diverse literature. We intend to answer the question posed at the beginning of this chapter. We will develop a process that relates the humanities and sciences to improve not only human welfare but also ecosystem and environmental health upon which human welfare depends.

3 Road Map for Overcoming the Barriers: Design of the Processes and Institutions for Tackling Wicked Problems

Much of the academic literature on restoring ecosystems and ecosystem-based management analyzes these challenges in terms of traditional regulatory, market-incentive, and collaborative process approaches. With some exceptions (e.g., Miller 1999, 2, 3; Ison and Collins 2008; Brown and others 2010) this literature does not generally approach restoration of lands and sustainability as "wicked problems." Yet analyzing these issues as wicked problems has implications for decision processes, the selection of policy tools, and the types of actions developed to address those problems. Many of the scientific analyses view these problems of land restoration and sustainability in terms of biophysical systems detached from the societal context of values, cultures, human communities, and their economic actions. Some of these analyses view restoration challenges through the lens of a particular scientific discipline and explore how to maximize a single biological or physical feature, though a growing literature emphasizes the need for a multi-dimensional, ecosystem-based analytic framework.

Recall in the introductory chapter that we defined restoring and sustaining lands as "wicked problems because they require decisions at the interface of science, engineering and technology, governance and policy, ecology, culture, values, and livelihoods." We divided the book into the central three sections because of these properties. It is important to keep in mind that "wicked problems have no solution only better or worse outcomes." The problems themselves constantly evolve within a context of dynamic social and natural systems.

4 Rethinking the Framework for Restoring and Sustaining Lands

Although a rich literature on the science and policy of ecosystem restoration and ecosystem-based management and recent books offers an analytic framework similar to the general framework articulated here (e.g., Chapin et al. 2009; Armitage and Plummer 2010), we amplify and extend the framework for tackling wicked problems by blending the perspectives of environmental policy makers, natural scientists, modelers, planners, and resource management practitioners. We bring diverse and rich experiences with the intersection of social systems and the management of natural resources and environmental policy to our discussion. Yet we do not consider ourselves "authorities." We consider ourselves students.

Among the many lessons we have learned is how much wisdom resides among diverse people in diverse communities. Collaborative decision-making institutions and processes must reflect that diversity and endeavor to tap into its wisdom. No matter how similar situations may appear, each is unique because of the diversity and complexity of social systems and ecological systems. This uniqueness complicates problem definition. Defining the problem, or set of problems, is a key factor in designing the framework for addressing the problem. Uniqueness of circumstances also constrains, or even obviates, a formulaic approach to land restoration. It necessitates a flexible and adaptive approach and process for policy formulation and implementation, management, and governance. Adaptation is well understood as a place-based endeavor. But what are the boundaries of that "place?" How do we measure those boundaries – physically, geographically, politically, jurisdictionally, culturally, or socially?[20] How participants in collaborative processes define these boundaries can affect the prospects for effective governance, policy, and natural resource management.

[20] Political parties perversely understand the importance of boundaries. Both gerrymander congressional districts that cut across jurisdictional boundaries of counties and municipalities.

4.1 Approach and Process

Some general procedures for undertaking collaborative processes for land restoration projects apply whether convened by government agencies, nongovernmental organizations, or citizen groups. *While certain procedures apply in most collaborative settings, there is a continuum of approaches for restoring lands as discussed above, and the approach must fit the scale and goals of the problem.*

4.1.1 General Procedure

We presume the overarching objective of land restoration efforts is to achieve productive harmony among ecological, social, and economic systems as described by the Dynamic Productive Harmony model.[21] Recall from Chap. 1 that the choice of conceptual model fundamentally determines the dynamics of the decision-making process and formulation and implementation of policy. Deciding on which conceptual model guides the process is by no means trivial. All parties need to agree that a healthy ecosystem is the foundation for robust social systems and dynamic economies. Yet this proposition alone is likely to result in some disagreement.

Dialogue among potential participants in collaborative natural resource management needs to begin at the beginning – that is, such dialogue needs to center on whether participants can identify shared general goals and agree to an overarching conceptual model to guide the process. Collaborative processes take a great deal of time and are front-end loaded; meaning a lot of time is spent at the beginning of the process before any action is taken.

Before any approach and process of the continuum of participatory processes are decided upon, it is necessary to:

- First, conduct an issue (also called stakeholder, situation, or conflict) assessment to determine if a collaborative process approach is appropriate or possible (Susskind and others 1999);
- Subsequently, initiate a human geographic mapping (Chap. 19) and social mapping (Clark 2002) process.

These three elements (issue assessment, human geographic mapping, and social mapping) should be part of the preparatory research before beginning any intervention (policy formulation). The potential success of restoration depends on the preparatory work, and there must be a willingness to put in a substantive effort, which requires funding and time. The reasons for undertaking human geographic mapping are articulated in Chap. 19.

[21] We do not consider specific issue conflicts of short duration (1 year or less), which are appropriate for environmental mediation, as relevant for the approach we develop herein. Ongoing stewardship situations of which the Tomales Bay Watershed Council is an example are the types under consideration here.

The following discussion is predicated on the assumption that a participatory, consensus-seeking, collaborative approach has been embraced. The participants are self-selecting. In other words, the convening organization has no voice in deciding who will and who will not be part of the process. The participants will emerge from the issue assessment. We would expect representatives from diverse sectors that include governments, citizens, nonprofits, environmental groups, businesses, farmers, and community groups – those that believe they have an interest or stake in the place and associated issues. Some well-established practices limit the size of the group so that productive discussions are possible while still ensuring that all interested sectors and actors are represented.

The first order of business, after establishing group ground rules, is to define the problem or problem sets and clarify the goal or goals (Clark 2002). This step is critical; it is the foundation upon which all future discussions will be based. If consensus[22] cannot be achieved on the problem(s) and goal(s), there is no sense proceeding with the collaborative decision-making. Often, it will take a great deal of time for participants to reach a consensus decision on problem statements and goals.[23] Once the problem(s) and goal(s) are determined, the group is able to define the questions to ask and the ways to address the problem(s). The chapters in Part II illustrate several possible tools and methods that can be used as part of a participatory, collaborative process that tackles wicked problems. The tools and methods are aids to the conversation. That is the problem is not defined to fit the tool or model. The appropriate research, tools, methods, or models is chosen only after the group has decided upon the problem(s) and goal(s).[24]

What we have described in the above paragraph so far is a conventional collaborative process that has been used for over 30 years to help solve social problems with uneven results. Elsewhere in this book, we have mentioned the debate about the effectiveness of collaborative processes for ecosystem-based management. A process called "collective impact" is different from conventional collaborative processes and holds promise for improving the success rate of collaborative approaches for solving wicked problems.[25] "Unlike most collaborations, collective impact initiatives involve a centralized infrastructure, a dedicated staff, and a

[22] NB: Consensus does not equate to unanimity.

[23] At MIT we developed a role-play simulation called the Owl Game about the spotted owl/timber harvest controversy. The game is to be played within 90 min. The first order of business is to define the problem, which initially seems obvious. Often the participants spend almost the full ninety minutes on reaching consensus on the problem definition. A Bureau of Land Management natural resource manager said it was the most realistic game he had played.

[24] Many scientists, engineers, and modelers have a large personal investment in their research and model. They tend to promote, either consciously or subconsciously, their particular research or model as the way to solve the problem – the problem usually defined by them. Until the problem is defined by all stakeholders reaching consensus, the appropriate way to solve it is cannot known.

[25] Kania and Kramer (2011) do not talk about wicked problems. They talk about adaptive problems, which by the way they define them are wicked problems.

structural process that leads to a common agenda, shared measurement, continuous communication, and mutually reinforcing activities among all participants" (Kania and Kramer 2011, 38). These are characteristics of the Tomales Bay Watershed Council, which has been so successful in ecosystem-based management and balancing the dynamics of the coupled social, economic, and natural systems. Of the five conditions for collective impact success – common agenda, shared measurement system, mutually reinforcing activities, continuous communication, and backbone support organization – the backbone support organization in our view is the only one unique to collective impact. Well-designed consensus-seeking processes incorporate the other four. Yet these four conditions do not guarantee successful collaboration and improved outcomes. Success depends, in part, on whether collaborative processes are well designed and managed as well as on the particular circumstances and the commitment of participants.

Both the conventional collaborative process and collective impact approaches require collaborative learning. Both require that stakeholders adjust their perspectives, their relationships with one another, and, even, how they behave in the collaborative setting in order for creative solutions to be envisioned and endorsed. Achieving these sorts of adjustments puts a premium on understanding the values of the diverse stakeholders. Human geographic and social mapping helps to illuminate stakeholder values. As explained in Chap. 12, understanding values is important in multi-party negotiations – many decisions are based on values. Participants need to acknowledge those diverse values explicitly in the development of collaborative processes and institutions and the implementation of models of network or shared governance.

5 New Institutions and Governance Models

> Shifting from isolated impact [conventional collaborative process approaches] to collective impact is not merely a matter of encouraging more collaboration or public-private partnerships. It requires a systematic approach to social impact that focuses on the relationship between organizations and the progress toward shared objectives. And it requires the *creation of a new set* (emphasis added) of nonprofit management organizations that have the skills and resources to assemble and coordinate the specific elements necessary for collective action to succeed (Kania and Cramer 2011, 39).

Collaborative processes do not imply that participants continuously agree. Disagreement will be part of any collaborative dialogue. Partisan disagreement in the political arena often results in dysfunction. However, in the collaboration arena, disagreement and conflict, when managed well, can lead to creative solutions.

Formal governance structures may not be well suited to provide the governance "glue" that sustains collaborative conservation. Those formal structures align with geographic boundaries that may be incommensurate with the tableau relevant for effective action. Moreover, those formal structures reflect a segregation of issue responsibilities that can impede ecosystem-based or more integrative approaches to resource management problems. We described earlier the potential importance of cross-jurisdictional, multi-issues governance frameworks that support public participation in decision making. Nobel laureate Elinor Ostrom has described many historical instances, decision-making compacts, associations, and other institutions that provide contexts and rules for collective and collaborative resource management. Many of the organizations that she describes are relatively small scale. Nonetheless, they provide insights into how collective and collaborative resource management can occur.

Institutions similar to those described by Ostrom have begun to emerge in what might be called an institutional discovery process. Many of these are nonprofit organizations; some are loose affiliations without formal governance structures. Though such institutions are emerging, in many cases their absence is a critical missing element in current collaborative process groups. They are particularly relevant when collaborative initiatives involve many different participants taking actions over an extended period of time that require ongoing coordination, accountability for results, and funding.

Several examples illustrate the institutional innovations that are emerging to support collaborative conservation and resource management. In the Malpai Borderlands in Arizona, along the Mexican border, a number of ranchers participate in the nonprofit Malpai Borderland Group. The group created a grassbank – an easement across hundreds of thousands of acres – through which grasslands are conserved and restored while enhancing ranching opportunities. Within the grassbank, grasslands flourish to provide prairie habitat for wildlife. Yet the grassbank is also akin to an insurance policy: during times of drought or fire, participants can move their cows, temporarily, onto the grassbank to assure their survival. This linkage of conservation with economic benefits is a natural lure for ranchers to participate, and the grassbank offers opportunities for landscape-scale, cross-boundary land and water management. The nonprofit organization provides a context for ongoing collaborative decision making and fundraising and provides the basic rules by which the grassbank operates. Across the nation in the northeast along the Duck Trap River in Maine, over two dozen partners, including landowners, snowmobile enthusiasts, local, state, and federal agencies, farmers, conservation organizations, and other joined in a management coalition to restore miles of the river and adjacent lands to improve salmon habitat while maintaining recreation, farming, and other land uses. The Duck Trap Coalition unpacked problems into bite-sized chunks. The Coalition applied new techniques to mitigate erosion. Members rehabilitated gravel pits, transforming them into vernal pools. They created an education partnership with the snowmobile association to maintain recreation opportunities on trails least subject to environmental impacts and monitored by the association. They used conservation easements to achieve enduring protections. The partnership is bringing miles of restoration to the river. It has generated permanent protections of lands and waters, blended with continued landowner and community use. It has generated data and monitoring by volunteers, recognizing that the true test of conservation resides in the results achieved and sustained. Both the Malpai Borderlands Group and the Duck Trap Coalition provide a forum for shared governance across land ownerships and jurisdictions. They also provide an organization that serves as the interface with public agencies.

Similar nonprofit organizations have been created with public agencies as the catalyst. Creating watershed trusts through state action or collaboration among cities and service districts to coordinate greening activities where a watershed and/or metropolitan area includes many political jurisdictions and management districts. For example, the Southeastern Wisconsin Watersheds Trust provides an umbrella organization to coordinate stormwater management among 28 separate municipalities.[26] The Milwaukee Metropolitan Stormwater District (MMSD) has flood management authority across six regional watersheds. However, the 28 municipalities each have independent stormwater management authority. In 2002, MMSD passed a rule requiring these separate municipalities to adopt flood management measures that include addressing stormwater. This rule helped galvanize the 28 stormwater districts into a partnership resulting in the formation of a nonprofit organization that also includes other stakeholder organizations, universities, and municipalities. The organization helps coordinate and, eventually, will provide grants for greening of urban infrastructure in communities that encompass 411 square miles. Because the Trust was recently formed, its performance has not yet been tested or evaluated.

No organization provides a single formula for collaborative governance. Despite their many emergent forms, these organizations and new collaborative efforts share several challenges. An ongoing need for funding is a principal barrier. Nonprofits such as those described here do not guarantee that funding will be available, but they provide a formal structure through which to raise and manage funds. Other challenges include the need for transparency, accountability, and continuity. Well-designed governance structures establish clear roles and responsibilities of participants that provide accountability, and their rules of operation provide continuity even as individual participants change over time.

The recognition and acknowledgment that new institutions are needed to tackle wicked problems is gaining widespread acceptance. Yet their emergence presents continued challenges as these institutions intersect with public agencies and governments. Public sector rules and processes for sharing power are not well developed. Indeed, many statutes and regulations limit such power sharing. Limits on agencies entering into cooperative agreements with partners; federal requirements regarding advisory committees; rules that pertain to pooling of public and private funds; and many other implementation issues challenge ventures in shared governance. Yet, ultimately, sharing of power means co-management – adaptive co-management of natural resources and ecosystems. Some promising models exist such as the Boston Harbor Islands National Recreation Area. The Boston Harbor Islands National Recreation Area, under federal law, is managed in cooperation with the private sector, with municipalities surrounding Massachusetts and Cape Cod bays, with the Commonwealth of Massachusetts, and with historical, business, cultural, civic, recreational, and tourism organizations. The recreation area is managed through the

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[26] This example is adapted from a policy report by Lynn Scarlett, *Clean, Green and Dollar Smart* (February 2010) Washington, D.C.: Environmental Defense Fund.

Boston Harbor Islands Partnership comprising 13 members, including representatives from the federal government (National Park Service and U.S. Coast Guard); the State (Department of Environmental Protection, Metropolitan District Commission, Massachusetts Port Authority, Massachusetts Water Resources Authority); the City of Boston (Office of Environmental Services); Boston Redevelopment Authority; Thompson Island Outward Bound Education Center; the nonprofit Trustees of Reservations; the Island Alliance; and two members of the Boston Harbor Islands Advisory Council.

The National Park Service Northeast Regional Director provides the Partnership with staff, including a park Superintendent, as well as technical assistance. The Partnership functions under provisions of a Partnership Charter and Bylaws and coordinates the activities of Federal, State, and local authorities and private sector in developing and implementing an integrated resource management plan for the Boston Harbor Islands NRA. The Federal government provides some base funding with the rest coming from actual island landowners.

To accomplish this model of shared governance required a special act of Congress. Similar examples such as the Las Cienegas National Conservation Area and the Valles Caldera National Preserve and its affiliated Trust also required acts of Congress that enabled these public-private ventures to operate unconstrained by some federal restrictions on fundraising and public participation in decision making with federal agencies.

The need for new institutions and forms of adaptive governance is well articulated by Scholz and Stiftel (2005). They examined water systems that cross multiple jurisdictions and the dynamics of these systems as part of a functioning ecosystem, which mandates habitat restoration and preservation. "Problems of this scale inevitably involve collective action challenges of great complexity. … Water quality, water supply, and habitat conservation are often the province of specialized authorities at local, state, and federal levels…. Ironically, the very success of these specialized agencies brings about the expanding range of water conflicts…that emerge as decisions by one authority impact other authorities and the users they govern" (1). The go on to say, "Coordinating policies across fragmented arenas could produce considerable benefits for stakeholders jointly affected by the decisions of specialized authorities, but *this requires combinations of expertise, authority, and representation of users that are not yet an established part of the institutional structure of governing water resources*" (emphasis added) (3).

A major question in the collaboration field is over what spatial extent can the process of consensus-based collaboration operate? We know that consensus-based processes are effective at local scales (Chap. 20 provides one example). Can a regional scale entity operate in that mode? Can local collaborative groups, be networked over a region? Milwaukee is pioneering a multi-jurisdictional, public-private collaborative effort for stormwater management. There are many other places in which such collaboration may be useful. For example, there are many watershed associations in the New England states. Could these associations become components of a Watershed Council? Another question is how durable are these collaborative entities (both individuals and networks)? Can they function as stable institutions?

6 Private Lands Stewardship and Productive Harmony

In Chaps. 17 and 18, we addressed community-based ecosystem stewardship in the public lands of the west. We touched on facets of private-sector stewardship in Chaps. 20 and 21. What processes might foster ecosystem stewardship of privately owned land, especially land not prepared for crops? The first sentence of this book introduced an eastern Nevada rancher who understood that managing his ranch for a healthy ecosystem benefited his family and all of society. We know agricultural practices can disrupt and degrade ecosystems, but food production is, of course, essential. A central challenge is how to lighten the environmental footprint of agricultural practices. The Conservation Reserve Program (CRP) is one attempt to set aside and keep a portion of agricultural land in natural cover. Although this does not insure ecosystem integrity, it does help to preserve habitat for a number of species. A prime motivator for the CRP is to provide cover for game species. Can programs like this be expanded in spatial scale to provide contiguous areas compatible with the area necessary for normal ecosystem functions? What conservation practices might operate on working lands – lands still managed for agriculture? Can private landowners embrace adaptive management and ecosystem management practices, as did the Nevada rancher so that these practices become common?

The Manomet Center for Conservation Sciences[27] is currently involved in a multiyear climate change adaptation effort in watersheds in Eastern Maine and Massachusetts. The project is focused on the development and implementation of climate change adaptation plans at both the landowner and landscape scales.[28] At both of these geographic scales, a broad spectrum of stakeholders and interests will be involved. The complexity at the landowner scale is the result of the interaction of economic, ecological, policy and social spheres. The complexity increases at the landscape scale with the addition of multijurisdictional interactions. Manomet is working with federal, state, and local government partners and landowners to identify and implement the best climate change adaptation measures. The team expects to develop climate change adaptation plans for each of the sites, analysis of the stakeholder process, and policy recommendations. The lessons learned through this process will be synthesized into sector-specific guidance. Students will use the climate change adaptation program as a framework for the exploration of challenges associated with maintaining the viability of ecosystem services under the stress of climate change. A primary goal is to establish an enduring collaborative stakeholder process and institutional arrangements to inform decisions in changing climate.

[27] http://www.manomet.org/

[28] Eric Walberg is the project manager; http://www.manomet.org/node/220

7 Opportunity for Achieving Productive Harmony and Sustainability

Experiments like those above are necessary to achieve productive harmony among ecological, social, and economics systems – sustainability. Other experiments need to encompass the continuum of process approaches discussed in an earlier section. The experimental design cannot stay within the realm of academic theory and *ex post* analyses of cases; *it must be implemented and tested on the ground through action research.*

The NRC (2009, 90) asserts that current institutions and decision-making processes are not adequate to deal with changing climate (one can substitute "restoring and sustaining lands" for "changing climate").

> We conclude by suggesting that the federal government fund studies of social networking, boundary organizations,[29] and other mechanisms that enable deliberation with analysis on climate-related [land restoration] response options among public- and private-sector organizations; build on models such as the RISA centers to expand the body of practical experience in using networks and boundary organizations to address issues of climate change [restoring and sustaining land]; and work with philanthropies and other nongovernmental organizations to develop innovative ways of coordinating networks and supporting boundary organizations to provide distributed mechanisms for learning to provide climate related [land restoration and preservation] support.

Many such reports have been produced. Many, however, do not actually influence decision-making structures and processes. As Holling and Chambers (1973) note, many agencies and universities re-label activities they are already doing or reorganize under different programs giving an illusion of change.[30] As the NRC report states in its last sentence, "…there is an opportunity to empower people to face a transition to a world that people have remade and continue to remake" (137). This is the opportunity the American public has to develop a process of productive harmony and sustainability.

8 Outlook for the Future

"Why am I here, I don't understand? We invited you here because the arguments we are having now are the same we had 20 years ago, and we hope you can help us move forward. Well, if you are not willing to take a risk and try something new, you'll be having the same arguments 20 years from now." This is a conversation that

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[29] See Chap. 6 for a discussion of models as boundary objects and Chap. 10 for a discussion of boundary organizations.

[30] If there is disagreement that this is not typically the case, why then do so many editorials, reports, and scholarly articles continue to urge the changes discussed in this book? Small steps have been taken, but not the giant leaps necessary to tackle effectively wicked problems.

Karl has had with more than one group asking his advice on dealing with contentious environmental and natural resource management issues. What is amazing is how often groups choose not to try something new. Continuing past practices is often safer than risking the unknown. Sometimes such traditional practices are undertaken with increasing frequency or intensity. In attempts to satisfy a displeased public, agencies, for example, will hold more frequent public meetings. These meetings usually are structured with agency personnel (or city council members, or other public officials) sitting on a raised platform in front of the audience. Participants in the audience are allowed a limited amount of time to comment (sometimes as short as 1 min each). Often, the participating public becomes more frustrated as more and more meetings of this type are held. Yet conveners seldom change the format of the meeting.[31] Engaging the public as equal participants in decisions that affect them might change the entire dynamic. Once the problem is perceived as being shared by all and the responsibility for solving it taken on by all, then fingers stop being pointed and the door is open to creative solutions (see Chap. 20).

"Society now seems to be facing problems of resources and environment, however, that are more extensive than those experienced in the past." In the 37 years since Holling and Chambers (1973, 13) made this statement, have our problems diminished? Some problems have diminished, others have emerged, and some problems have persisted and even worsened. Climate change is exacerbating the problems we face; "…climate will continue to change – and at the same time, social and economic changes are altering the vulnerability of different regions and sectors of society to climate change, as well as their ability to cope with climate change. … Decision makers … need new kinds of information, as well as new ways of thinking, new decision processes, and sometimes new institutions, to function effectively in the context of ongoing climate change" (National Research Council 2009, 9). In the past, ecosystems and communities have been sufficiently resilient to absorb the impacts of natural disturbances and human activity. However, "resilience is not infinite" and "…three hundred years of ignoring these limits has left us with a baggage

[31] San Francisquito Creek is a small creek in northern California (Rofougaran and Karl 2005). It is the boundary between two counties and flows through five municipalities. It is the last remaining riparian creek in that area of the San Francisco Bay. A Joint Powers Authority (JPA) was established to manage the land in the San Francisquito Creek basin. Management of the ecosystem was very contentious with some municipalities wanting the land preserved as the last remaining riparian creek and others wanting it developed for an increased tax base. The upper reaches of the creek are inhabited by some of the wealthiest people in the world and the lower by many people near or below the poverty level. These economic disparities mirror racial differences as well. Because of the conflict, an environmental mediator and the National Park Service suggested that the JPA meet around the table with residents of the watershed to have a conversation about the creek facilitated by a neutral. All agreed, particularly the JPA (who had difficulty talking with each other), this was the most productive and constructive meeting they had ever had. They never held another collaborative meeting after it. All subsequent meetings were the conventional format of JPA members sitting on a raised platform with citizens being allowed a limited time to speak. The conflict continued unabated.

of approaches and solutions that are only admirable as instruments for resolving fragments of problems. Wherever we look there are gaps – gaps between methods, disciplines, and institutions" (Holling and Chambers 1973).

We are in a period of transition and evolution with regard to managing the dynamics of coupled natural and human systems. Societies are experimenting with many emergent combinations of approaches to restoring and sustaining lands. And societies can shape the evolutionary outcomes of these experiments. The outlook for the future depends on whether we will make the tough choices to develop "new kinds of information, as well as new ways of thinking, new decision processes, and sometimes new institutions" and have the courage to implement them. In the previous section we laid out some specific approaches and roadmaps for collaborative resource management, which are a synthesis of well-known methods, processes, and concepts. *Most importantly, we should not continue <u>to plan</u> for sustainability, but, as discussed in Chap. 13, <u>to design</u> for evolution. That is our challenge and opportunity*. Caring for the land is ongoing and attaining sustainability is not an end point – it is a dynamic, never-ending process of stewarding coupled interdependent natural and human systems. Those of us who love the land and consider it an extension of and integral with the human community and experience must keep in mind that

> We shall never achieve harmony with the land, anymore than we shall achieve absolute justice or liberty for people. In these higher aspirations the important thing is not to achieve but to strive.
>
> (Leopold 1993, 155)

We end with this passage by Theodore Roosevelt (in Morris 2010, 440), which elegantly and eloquently answers the question with which we began this book:

> The extermination of the passenger-pigeon meant that mankind was just so much poorer; exactly as in the case of the destruction of the cathedral in Reims. And to lose the chance to see frigate-birds soaring in circles above the storm, or a flight of pelicans winging their way homeward across the crimson afterglow of the sunset; or a myriad of terns flashing in the bright light of midday as they hover in a shifting maze above the beach – why, the loss is like the loss of a gallery of the masterpieces of the artists of old time.

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Appendix A
The Partnership Series

Fostering Community-based Ecological Stewardship with Place-based Learning

Charles E. Pregler (retired), BLM National Training Center

1 Origin and Objectives

In late 1994 in my job as a Training Coordinator for the Bureau of Land Management's National Training Center (NTC), I heard several expressions of "need for training on partnerships". I began an assessment in early 1995 of this emerging need and started to add to our existing network of practitioners and scholars who taught in the biodiversity and ecosystem management courses. In June 1995 a small group met in Phoenix to design what became the original course, Community-Based Partnerships and Ecosystems for a Healthy Environment, which was piloted in November 1995.

It is important to note that we (I, my NTC supervisors and the training cadre) were operating without specific direction or guidance by the BLM Washington Office or other higher offices in the bureaucracy. We were in operation about 18 months before they discovered the effort existed. This was not by accident; we had concerns that the whole effort would be labeled "land use planning" and become limited by that traditional approach. There was a semblance of movement toward community-based approaches at the time in the United States paralleling other efforts in the world. We saw our task as helping to build the social capacity needed to support collaboration among government and citizens at the community level, and incorporating science into that dialogue to help define and guide responsible land stewardship. We were in fact pioneering and refining a new way to work that we later came to call community-based ecological stewardship (CBES, Chap. 17).

Over the years several people have asked me "Why did this happen within BLM?" rather than one of the other federal land management agencies. I think there were several reasons:

1. **NTC Environment** In the 1980s and 1990s at NTC, the role of training coordinators and the management philosophy allowed for great creativity and innovation. People in those jobs had control of budgets for their sub activities, were allowed to quickly assess training needs, could build support and funding for needed curricula and select the best instructors for the topic and audience.

H.A. Karl et al. (eds.), *Restoring Lands - Coordinating Science, Politics and Action: Complexities of Climate and Governance*, DOI 10.1007/978-94-007-2549-2,

2. **Biological Diversity and Ecosystem Management** During the late 1980s and into the mid-1990s there was a strong initiative for biological diversity and ecosystem management throughout the Department of the Interior agencies and in the USFS. NTC was in the forefront of training in those topics. In some ways the Partnership Series built upon those efforts.
3. **People** As in other cultural change movements, the confluence of certain people is critical. Some in our network like Gary McVicker (career BLM employee and primary architect of CBES) and James Kent (social ecologist and human geography leader) have been traveling this path and refining their ideas for decades. Others were actively recruited into our early network or like Gene Williams (rancher from South Dakota) were drawn to the strength of the ideas. Kevin Preister, Mike Preston and a host of others contributed much to the formation and evolution of the PSeries. My background in biology, field experience with BLM and tenacity to find ways to do things that agency employees are often told we "can't do" no doubt were factors as well.

2 Business Operations and Finance

I attended a cocktail party at the North American Wildlife Conference in Washington, D.C. in the winter of 1995 and met a woman who was to play a major role in the business, financial and operational strategy in the original formation of the Partnership Series (PSeries). Kris Komar was a nonprofit partnership specialist and had been in the original design cadre and an instructor during the first 2 years of course deliveries. She provided the business idea for and helped construct a nonprofit-federal partnership to support the design, marketing, sales and delivery of the emerging training courses. We created an identity for the courses, identified potential audiences, and developed business, marketing and communications strategies (Partnership Series 1998). It was clear that federal funding and staffing would not be adequate to operate and fund the anticipated workload to deliver courses and ongoing technical support to our audiences. I should clarify that the term "PSeries" was often used to refer to (a) the products and services we provided and (b) the network of individuals involved in the delivery of those products and services.

At the peak of the PSeries operations there were five nonprofit employees working side-by-side with me and our instructor cadre. Our first nonprofit partner, the San Bernardino National Forest Association and later, the National Association of Resource Conservation and Development Councils, hired staff with critical marketing and sales skills not available at NTC, collected site sponsorship fees directly from customers, kept an up-to-date and accurate bookkeeping system separate from NTC, created innovative and efficient operating procedures and worked tirelessly to coordinate the often underappreciated delivery logistics. The operation worked so well that other NTC staff began to envy our processes and abilities; we mitigated those issues, shared our ideas and supported those interested in following suit.

The PSeries often drew the suspicious attention of agency grants and agreements and audit personnel. In two separate fiscal audits we heard "*no one else does it like that*" and "*we can't find anything you are doing that is illegal*"; despite repeated requests to document our clean operations those findings were never put in writing.

At NTC Dennis Oaks (Division Chief in Lands and Renewable Resources) became a key financial and agency champion of the PSeries after attending a delivery of the CBES course in Safford, Arizona in 1999. We found that if we could get key people to attend the CBES course, watch the interaction and listen to citizens and agency folks in a collaborative dialogue they would become strong supporters; just reading or hearing about the event was often not enough. As we came to realize the CBES "course" was more of an experience than prescriptive; it had to be organic and natural.

From a business standpoint it was desirable to have a variety of products and services for customers; one product that sold well might supplement the costs of another not selling as well. The idea was to financially support the additional learning that might be needed to foster CBES.

3 Evolution

The network of people involved in the original Community-based Partnerships course struggled with its content and focus for several deliveries. For example: the discussion over whether what we were delivering should be called "training" persisted for our entire 11 year history. The training cadre was divided whether it should be about partnership fundamentals or about what eventually came to be called CBES. Even the term "partnership" was contentious in that some felt it carried baggage of old ways of doing business and implied that we were merely about improving how well we partnered to do the same things for the wrong reasons. The debate came to a head in 1998 in Denver with a change in the cadre and the evolution and eventual renaming of the course to Community-based Ecological Stewardship.

Though originally a single course, from the beginning the network envisioned a suite of courses to support the central concept of CBES, thus the plural name. The desire for a suite is also what drove our work within a business environment so that we could raise the capital to build more courses. The Community–based Partnerships course remained the flagship for the PSeries. As James Kent taught us the strong affinity that people have to place, human geography and the power of informal leaders and networks, the Learning Community course was added to the PSeries. With the realization that community stewardship groups pursuing CBES often formed nonprofit organizations and would need strong financial strategies the Alternative Funding course was designed and offered. Since communities always face the traditional methods of evaluating economic consequences of land use decisions without looking at amenity values or natural resources as the basis of the economic or social values, the Community Economic Assessment course was created. The Place-based NEPA course followed shortly thereafter to aid communities and citizens in becoming more effective in agency NEPA processes. Brief descriptions of all the courses are in Table 1.

The Introduction to this book states it is a "…narrative of diverse voices that collectively talk about coordinating science, politics, and community to manage ecosystems in harmony with social and economic systems…" The PSeries network observed that science was and may still not always be used to inform land use decisions. The Science in Service of Stewardship course was intended to foster trust of sources of science and of scientists, to develop respect for local wisdom, and to include citizens and agencies in focusing the science on the right questions (but not the scientific methods) for land use decision making. Herman Karl and Christine

Table 1 Description of training courses in the Partnership Series, 1995–2006

The Partnership Series' products and services are useful when communities are facing barriers to collaboration. The material points the way to work together on developing common goals, reducing conflict and creating collaborative stewardship. The training courses are delivered in your community.

Community-Based Stewardship and Ecosystems: Ensuring a Healthy Environment

This course offers an overview of the social, ecological, and economic realities facing communities today. The course presents methods to approach emerging issues to bridge competing positions and interests and to develop a community vision. Participants will take a glimpse of the possibilities for the future, learn how to rebuild social capital through networking and actions with other community organizations, encourage community-based ecological stewardship, break down barriers and see the future differently.

Community-Based Ecosystem Stewardship Primer

This course is intended for communities that have previously hosted the full CBS course above and is tailored to their specific needs. It is intended to bring new community members and agency employees up to speed with CBES and reinvigorate stewardship efforts.

Alternative Funding: Looking Beyond Traditional Sources

Participants will learn the influence of traditions of government appropriations, philanthropy and organization change on their current project or job situation. Participants will develop a strategic funding plan, gain broad knowledge of how to conduct internal and external evaluation processes to determine if their organization is prepared to undertake alternative funding activities, learn sources of alternative funds, learn how to create fundable projects, add value to their project and practice interpersonal skills and making your case to potential funders.

Learning Community: Linking, People, Place, and Perspective

This course stresses the importance of both formal and informal networks, identifying issues, and inclusiveness. This experience enables you to see your community with new eyes. Participants will discover how to respect and utilize the diverse opinions that may exist within your community, move forward with a community-based project and develop a plan of action, learn how to build advocates in your community by identifying those affected by an issue and including them in the solution and explore networking opportunities.

Community-Based Volunteering: Enhancing Land Stewardship Through Innovative Partnerships

This course prepares participants to engage with organization leadership to create a strategic vision for a volunteer program that serves the needs of the land, the community and partners. Participants will learn basic marketing strategies and be able to apply them to all elements of a volunteer program and in terms appropriate for agency volunteer programs. Participants will review program development steps, key components for success, incorporate what motivates people to volunteer into your program and communicate program values, desires and successes to establish a strong interactive volunteer program.

(continued)

Table 1 (continued)

Community Economic Assessment: Discovering Realities and Choices

Participants will look at the actual economic basis of a community and gain insight into future trends and choices. Learn to integrate formal information into knowledge to shape policy decisions on public lands, gather data by both manual and automated methods to make informed decisions about the future describe the connection of public lands to local economies and build confidence in understanding the role of economics.

Place-Based NEPA: Linking Communities to the Process

The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision-making processes. This course helps communities consider the environmental impacts of their proposed actions and reasonable alternatives to those actions. Participants will gain an overview of the NEPA process, set the stage for a collaborative community approach to planning, and define the parameters wherein agencies and citizens can work together, expand the decision space available and sideboards in the planning process and tie to local stewardship efforts.

Science in Service of Stewardship

This course focuses on the role of science in community-based stewardship and on communities and government agencies working collaboratively to frame issues, design ways to jointly gather and analyze factual information, and develop practical options that move communities closer to a "productive harmony" between people and the land. Participants will use local, indigenous, and scientific knowledge to create common understanding of the ecology, collectively formulate scientific questions and experiments that help guide resource decisions, jointly assure trust among scientists, resource managers, and citizens, develop collaborative monitoring and foster a culture of collaborative learning and inquiry.

Turner along with Gary McVicker and Todd Bryan were essential to this design and delivery.

As agency budgets began to shrink in the late 1990s, travel and training costs were under growing pressure to be reduced. The number one reason people were not attending training was time away from their regular jobs. One manifestation of this was a renewed and sometimes dogmatic push at NTC for class delivery via satellite, computer or the internet. As the training leader for the PSeries, I was directed in 1997 to bring in the cadre and convert the CBS course to a distance learning format. In my 22 years at NTC this was the only training design team that said "no" and refused to do so, much to the consternation of my Division Chief at the time. The basic objection (rightly so as it turned out) was that people don't build trust with television screens. Since trust among citizens and agencies is critical to building capacity for stewardship and since many people still want to watch your body language and get to know you before they begin to develop trust, a face-to-face delivery was deemed essential. The synergy of place-based learning can quickly develop with local wisdom and higher attendance by community members alongside agency personnel once <u>trust of the source</u> of the information is established.

One observation made by the PSeries network was that with turnover in agency personnel and in communities the momentum for CBES slowed over time. Research studies (Wondolleck and Yaffee 2000) show that it only takes two or three motivated individuals in a community to provide a nucleus for these efforts to form and grow. In order to keep that minimum number and to provide a "booster shot" for CBES efforts the PSeries developed a Community-based Stewardship Primer course intended to foster renewed learning and reinvigorate local efforts.

4 Site Readiness and Support

We learned a lot (sometimes the hard way) about what we came to call site readiness. Selection of locations for PSeries events and services was always a critical step. We were always "invited in"; never "we're here to educate you." Land use planning by a federal agency often triggered an invitation because of the public involvement requirements of NEPA. Other invitations came thru efforts of our cadre or marketing. Because of the place-based reasons discussed above, we always delivered live in field locations. There were times I declined a request. We learned the hard way that sometimes a District Manager or Forest Supervisor was not going to walk the talk…to some it was just one of the items on a checklist. If things went back the way they were after we delivered, trust was lost with communities and the situation was worse than if we had never delivered. The presence of a transformational leader (Quinn 1996) was important.

In 1990 there were policy limitations that stipulated that only federal employees could attend training offered by NTC. I was sitting at my desk one day and got a direct phone call from the BLM State Director in Wyoming. He said "*I want you to bring the biodiversity course to Cheyenne and I will pay for it but I want to invite a large number of citizens to attend*." The NTC Director at the time said "*The State Director is asking…we'll do it*." The course was so enriched by the diversity of perspectives and knowledge that we always did them that way thereafter. NTC policy began to relax in the following years; current personnel are mostly unaware it was not always this way.

When we began developing in 1995 what became the PSeries this policy of inviting citizens to attend was already an accepted NTC practice. Given our strong belief that "people acting together to achieve durable solutions for restoring lands" should collaboratively learn together (from Introduction Chapter) it became our standard practice to work with site hosts and local network leaders to invite informal community leaders and key citizens to our class deliveries. When we could find ways to pay for it, "pre-site visits" by a couple of the cadre tried to help people themselves organize for the event. Most importantly, we wanted the contacts, invitations, and other information to come to people as much as possible through their own social networks. When we succeeded in doing that, the sessions were always much more alive and productive than when they were organized by/through the agency.

5 Locations and Mix of Participants

Two of the keys to the success of the PSeries deliveries were the place-based delivery (we went to their community) and the mixture of agency and citizens who attended. Table 2 shows the locations, dates and total number of participants for all of the classes delivered from 1995 through 2006 by the PSeries. Of particular note are the 1,400 participants in the Community-based Stewardship classes in 41 locations throughout the U.S. Almost 2,100 participants attended one or more of our deliveries in our 11 year history.

Our goal was no more than 30% federal employees in a class but proportions varied greatly with class and location. We had sportsmen, miners, ranchers, environmentalists, schoolteachers, activists, local government, wilderness advocates, off-highway vehicle enthusiasts, hikers, horseback riders and nearly any other interest in public lands you can imagine.

This rich mix of participants created the opportunity for dialogue among citizens and agencies that was place-based. One example illustrates the point:

> In Safford, Arizona the issue was Mexican wolves. Woman in audience: "*I can't imagine anyone in their right mind wanting to reintroduce wolves.*" A voice came back from someone else, "*I can and here are the reasons why*." He went on to explain why, which opened up a whole new discussion on the matter, one that had been effectively closed in the town up to that time.

6 Examples of Outcomes/Successes and Failures

As with any change initiative, we had some successes and some failures. In a survey by BLM (2006) field managers in place at the time of the PSeries delivery cited positive trends in community relations, meaningful community involvement, dialogue among citizens and agencies, increased community involvement and support for land use plans, diverse participation n the planning process, starting a partnership or stewardship group and shared decision-making as accomplishments resulting from a PSeries delivery.

A new way of government and citizens working together for productive harmony with the land is difficult to quantify…we were less focused on measuring success than moving communities toward stewardship. We did not know the processes that communities would select in a place and often said there was no cookbook. As Todd Bryan often quoted in the class "W*e're building the bridge as we walk across it*." We did see some specific results I would label as success.

<u>BLM Phoenix Field Office</u> Multiple citizen groups have formed since the first PSeries delivery there in 1998. Current community partners include the Upper Agua Fria Watershed Partnership, Bradshaw Foothills Coalition, Black Canyon Trail Coalition, Black Canyon Community Association, New River/Desert Foothills Community Association, Friends of Table Mesa, Agua Fria Open Space Alliance,

Table 2 List of class deliveries in the Partnership Series, 1995–2006

Location	Date	Number of participants
Community Based Stewardship and Ecosystems: Ensuring a Healthy Environment		
Phoenix, AZ	November 28–December 1, 1995	8
Butte, MT	September 9–12, 1996	33
Coos Bay, OR	February 25–27, 1997	49
Montrose, CO	April 28–30, 1997	35
Bend, OR	May 13–15, 1997	14
Ely, NV	June 17–19, 1997	33
Boise, ID	February 24–26, 1998	35
Big Bear Lake, CA	April 14–16, 1998	47
Elko, NV	September 15–17, 1998	31
Pinedale, WY	February 9–11, 1999	25
Safford, AZ	February 23–25, 1999	42
Tonopah, NV	March 9–11, 1999	31
Cloudcroft, NM	May 11–13, 1999	44
Yuma, AZ	October 28–30, 1999	52
Espanola, NM	November 4–6, 1999	34
Carlsbad, NM	February 9–11, 2000	35
Lake Pleasant, AZ	April 11–13, 2000	29
Farmington, NM	May 23–25, 2000	35
Silver City, NM	May 31–June 2, 2000	72
Cody, WY	February 20–22, 2001	41
Quincy, CA	March 27–29, 2001	36
Lake Havasu City, AZ	April 3–5, 2001	28
Waldorf, MD	April 17–19, 2001	42
St. George, UT	May 15–17, 2001	63
Winnemucca, NV	June 26–28, 2001	43
Parker, AZ	October 29–30, 2001	20
Bullhead City, AZ	November 7–9, 2001	n/a
Kanab, UT	January 31–February 2, 2002	38
Grand Junction, CO	March 12–14, 2002	40
St. George, UT	March 19–21, 2002	26
John Day, OR	April 16–18, 2002	40
Alamosa, CO	November 19–21, 2002	43
Lewistown, MT	December 3–5, 2002	39
Miles City, MT	April 7–9, 2003	43
Craig, CO	May 19–21, 2003	62
Dolores, CO	September 11–13, 2003	34
Taos, NM	September 8–10, 2004	19
Lander, WY	October 25–26, 2006 (part 1)	22
Fillmore, UT	November 3–4, 2006 (part 1)	18
Lander, WY	November 30–December 1, 2006 (part 2)	18
Fillmore, UT	December 8–9, 2006 (part 2)	28
Total CBS classes = 41		**1427**

(continued)

Table 2 (continued)

Location	Date	Number of participants
Community-Based Ecosystem Stewardship Primer		
Lake Pleasant, AZ	December 11, 2004	36
Elko, NV	February 23, 2006	29
Total CBSP classes = 2		**65**
Alternative Funding Strategies: Looking Beyond Traditional Sources		
Phoenix, AZ	May 4–6, 1999	18
Boise, ID	February 29–March 2, 2000	35
Total AF classes = 2		**53**
Community Based Volunteers: Enhancing Land Stewardship Through Innovative Partnerships		
Baker City, OR	February 15–18, 2000	22
Pocatello, ID	September 26–28, 2000	22
Great Falls, MT	October 2–4, 2000	26
Sunriver, OR	March 13–15, 2001	44
Knoxville, TN	August 28–30, 2001	34
Total CBV classes = 5		**148**
Community Economic Assessment: Discovering Realities and Choices		
Elko, NV	September 19–21, 2002	18
Taos, NM	August 22–23, 2003	33
Battle Mtn., NV	March 23–25, 2004	24
Cuba, NM	September 22–23, 2004	23
Craig, CO	February 24–25, 2005	27
Total CEA classes = 5		**125**
Learning Community: Linking People, Place and Perspective		
Lake Pleasant, AZ	November 30–December 2, 1999	32
Socorro, NM	May 30–June 1, 2001	44
Elko, NV	September 20–22, 2001	32
La Grande, OR	December 4–6, 2001	37
Total LC classes = 4		**145**
Place-Based NEPA Concepts: Linking Communities to the Process		
Battle Mtn., NV	August 27, 2003	30
Craig, CO	May 7–8, 2004	28
Taos, NM	Dec. 9–10, 2004	28
Total pbNEPA classes = 3		**86**
Science in Service of Stewardship: Linking Information, Knowledge, People and Place		
Elko, NV	February 24–25, 2006	33
Total SSS classes = 1		**33**
Grand Total All Class Deliveries = 63		**2082**

and Wickenburg Conservation Foundation. Challenges include loss of capacity due to turnover in both agency personnel and citizens.

Northeast Nevada Stewardship Group This group formed after the 1998 CBES delivery in the very midst of the "Shovel Brigade" and Jarbridge Road issues. The PSeries delivered at least 5 sessions to citizens in and around Elko, Nevada before 2006. Subsequently, some of those people then became involved in a citizen led effort to develop a Sage Grouse Recovery Plan. Unfortunately that plan later became a victim of a strategy for the state to take over sage grouse recovery. Nevertheless, northeast Nevada showed great promise in adopting the principles of CBES. Before that, the area had been known for its resistance to government. This experience serves to illustrate the idea that land health issues are often subsumed by other social and political issues, and that, once empowered and shown a way to get around those limitations, people can rise to the needs of stewardship

Northwest Colorado Stewardship Group This group formed after the 2003 CBES delivery in Craig, CO. Two additional PSeries deliveries supported their efforts. Oil and gas vs. wilderness and trust among all parties were big issues. There were some influences coming from government sources that put a damper on the process, some of which were driven by local politics that were not supportive of it. In the end, local politics just simply would not support the effort, even though it had a promising start.

Prescott National Forest (PNF) After the PSeries ended in 2006 I spent 3 years on the PNF as their Community Networks Specialist. I would describe that effort as a personal field application of the concepts and approaches we developed in the PSeries. As part of the Forest Plan Revision we mapped human geography around the PNF, identified informal networks and got 10 of 11 communities to write vision statements. Citizens formed a broad-based stewardship group who began working as one of the pilots for the USFS Sustainable Recreation Strategy locations. We fostered a nonprofit-PNF relationship to build capacity to collaboratively address on-the-ground resource issues. Some of the challenges faced were due to over-estimating the risk tolerance of the Forest Supervisor at the time, high cultural resistance of Grants and Agreements personnel to practices used in other Regions and cultural resistance to change using language like "*Not Forest Service*" when referring to me or procedures used legally in other agencies.

7 Attention Received

The PSeries received attention from a variety of Department of Interior and BLM individuals. I often heard the comment that the PSeries was the only place-based training in all of DOI. One Assistant Secretary for Policy, Management and Budget spoke favorably of the program; in 2005 the PSeries was one of the very few federal training programs invited to the White House Conference on Cooperative Conservation (2005) in St. Louis. One high level BLM leader was poised to mandate attendance at our events via a satellite broadcast and written memo from the Washington Office but did not after I pointed out that this would be "mandated collaboration".

In a report commissioned by the USFS to document available training on collaborative training written by the Pinchot Institute (2001, pp. 20, 42) found:

> The National Training Center's Partnership Series currently provides the best and easiest opportunity for furnishing the kinds of courses needed by the Forest Service to facilitate collaborative learning experiences. The Partnership Series has or can easily provide a cadre of people who understand the culture and history of the Forest Service, thereby framing the need and urgency for collaborative approaches.

The report went on to recommend that the USFS:

> Explore the possibility of joining and expanding the Bureau of Land Management (BLM) collaborative training effort at their National Training Center in Phoenix, AZ. In particular, the agency should evaluate the possibility of expanding the National Training Center's capability to provide quick and easy access to resources needed for specific collaborative activities by the communities of interests engaged in the process.

Despite two separate significant proposals to the Washington Office leadership suggesting the USFS join forces with BLM and co-sponsor the PSeries, co-sponsorship at the national level never occurred. For reasons tangential to the PSeries the USFS and BLM could not feel comfortable with joint efforts.

Researchers from both the Universities of Michigan and Colorado and several graduate students interviewed me in different years about the PSeries. Their interests were why it began in BLM, how we operated and our successes.

8 Factors Leading to the Demise of the Partnership Series

I believe it is useful to examine some of the factors that led to the cessation of PSeries operations and document lessons learned so that potential future efforts might avoid those. A few of those factors and lessons are listed below.

<u>Agency culture</u>
Throughout the life of the PSeries we enjoyed the credibility and reputation of the BLM NTC when BLM was the potential site host. However when other agencies were a potential host, sometimes there was agency cultural resistance to something seen as "BLM training". It appeared to not matter that the course design team included USFS and NPS members (not to mention university, consultant and citizen involvement) or that the instructor cadre had more USFS employees than BLM. For instance, I heard repeatedly that our products "*were not Forest Service*".

We often received kudos from BLM and USFS agency leadership; they liked the results they saw. The PSeries business plan depended upon the pool of all the USFS and BLM. When that did not happen our fiscal strategy was greatly weakened.

I described in the Business Operations and Finance section the pivotal role that Kris Komar played in that part of the PSeries. In 2000 the NTC Director made the decision to end her involvement; this had direct impact upon the success of our marketing efforts and financial strategies.

Agency stovepipe funding

Throughout the life of the PSeries we encountered a common agency paradigm of "stovepipe funding". Federal agencies receive funding in broad activity categories but become very programmatic when parceled out below that level. Unlike current BLM Washington Office organizational structure, during the run of the PSeries there was for the most part no national program leader or "partnership" program. The Alternative Dispute Resolution program at the time was focused on downstream resolution (post conflict) and not particularly interested in collaborative efforts (upstream of conflicts). The Land Use Planning shop in BLM liked what we were doing but did not consider our efforts part of their program. The overall effect was "*everybody loved us, nobody wanted to fund us*". It was only thru the support of Dennis Oaks, my NTC Division Chief at the time, that we received approximately $88,000 per year and my salary to work on the PSeries. The limited NTC funds and the sponsorship fees charged the site hosts were the prime funding sources for the PSeries.

Emphasis on operation of the PSeries as a business declined somewhat after the first few years. Some courses developed by the cadre were not marketable. When our efforts to expand the market for the courses were not successful and accompanying funds did not materialize, this was a major impact to continuation.

Institutional Priorities and the 2000 Presidential Election

In early to mid 1990s, Training Coordinators at NTC enjoyed a great deal of latitude and responsibility in their positions. They had control of the budget for their sub activities and could pursue trends and emerging needs, identify training needs, obtain funding and build curricula that met those needs. About that time NTC changed the budget authority back to the Division Chief level. The approval and design process for new courses and projects began to require multiple levels and to grow more cumbersome. Workloads became overloaded in part due to the required procedures, layers of decision-making and declining discretionary budgets. In the mid 2000s NTC leadership moved from a traditional agency training facility model to one for a community-college with more formal policies and procedures with slower responses to trends and emerging needs.

With the new administration after the 2000 Presidential election, institutional priorities and funding allocations shifted away from environmental concerns. Leaders went away from ecosystem management thinking; there was a shift in Washington to narrow the definition of stakeholders who should be involved in public lands management and away from inclusiveness. This explains in part the decline of trust in of government by many interest groups; many opportunities for broad-based collaboration were replaced by a resurgence of litigation and distrust.

Ability to collaborate internally

Throughout its 11 years of operation the core members of the PSeries cadre struggled with philosophical differences on the content in our events. Despite efforts in 2001, 2002 and 2004 to bring the group together, significant differences remained. Healthy debate helped to development key concepts but strong positions by some hampered delivery efforts and expansion of the group. Greater appreciation and value by the instructor cadre of the business operations and financial strategies to pay the costs of products and services would have helped sustain and grow the PSeries.

In 2003 strategic direction and decision-making differences between the National Association of Resource Conservation and Development Councils (the nonprofit partner) and NTC escalated. NTC had decided to taper off and end its funding support for the PSeries in part due to limited successes with our financial strategies. With the dissolution of the partnership in the fall of 2003 the staffing and skill capacity of the PSeries business operation was severely hampered. NTC management was decided against finding a new nonprofit partner and capacity remained low.

9 Lessons Learned

I want to share a few of the lessons we learned in our efforts to foster CBES. Some of these relate to the concept and likeliness of starting local efforts; others relate to necessary business operations and capacity to do the work.

1. **Site readiness** is critical to the success of CBES.
2. **Always be invited into a community**; never "we're here to educate you."
3. **Pre-site visits** with a couple of our cadre helped describe the coming delivery and improved site hosts efforts to prepare and get key participants to come. The more the event was seen as led by citizens, or at least co-led by them and the agencies, the better the attendance, meaningful participation and outcomes.
4. **Place-based** deliveries were essential; face-to-face contact is critical to begin.
5. The presence of a **transformational leader** and their willingness to take risks with such things as Grants and Agreement paradigms in the agency was needed.
6. Most of the **challenges to CBES are inside the agencies**, not outside. Agency culture often prevents or limits CBES success.
7. The **minimum number of people** to form a nucleus and lead the local CBES effort seems to be three. A mixture of government and citizen members is important and at least one should be a transformational leader (Quinn 1996).
8. **Broad-based audiences** from the community along with agency personnel were necessary. Including community members in inviting key participants and explaining the value greatly enriched the participant mixture.
9. The **local agency decision-maker should always attend** the event to listen, learn and show commitment to the CBES approach.
10. **More contacts** with the PSeries over a longer period had with a community the higher the chances of a CBES approach being adopted (BLM 2006). "Booster shots" every few years helps mitigate disconnect due to agency and citizen turnover.
11. **Agency champions** were most likely if they witnessed a delivery, not just read or heard about it.

12. The **cadre must practice collaboration** as well as preach it.
13. **Funding and staff skills from outside the agency are essential** to supporting CBES deliveries. Agency and nonprofit partnerships with well designed business and financial strategies are a good way to build operational capacity.
14. A funding means to **reduce or eliminate cost to field offices** is needed (BLM 2006); products and services must be marketable.

10 The Potential of Efforts like the Partnership Series

The successes mentioned above demonstrate place-based, collaborative learning can in fact foster CBES. It seems clear from our experiences in 63 deliveries that significant change in how government and citizenry work together toward a sustainable relationship with the land must begin at the local level. I believe government is incapable of changing itself to the new model that is needed. The role of the federal employee shifts from <u>doing</u> the work to <u>enabling</u> the work. As the participant in Ely, Nevada reminded us *"You all talk about citizen empowerment; you're just discovering that we've had the power all along."* If the people's will in a democracy is sufficient, government will change.

The biggest shortcoming of this experience was the lack of high-level agency support. It mostly fell to the local field office manager to bring the experience to the community; it was often difficult to effectively follow-up due to other agency priorities and demands. If people are to be <u>empowered</u> locally to become responsible and well informed ecological stewards of the public lands, that as an outcome must be fully understood and fostered up and down the chain of command for the agencies involved. There needs to be as much training inside the agency as out as well as a commitment to bring the most relevant and respected science possible to people. All of this needs to be aimed at citizen empowerment, not just participation.

One approach to encourage efforts like the PSeries might include a national program to: (1) identify and recruit agency personnel and citizens with the existing characteristics to practice CBES; (2) create a position for, train and financially and culturally support the placement of at least one individual in every BLM District or Field Office and every Forest Supervisor's Office and; (3) create and financially support regional cadres of experienced CBES practitioners who would provide ongoing technical support and advice to the local personnel and stewardship groups. Capacity built and community advocacy would of immense value. I would argue that even the financial costs would be more than offset by the value over the long term of collaborative efforts.

Given sufficient cultural support from one or more agency, modest funding and allowed to function free of false agency paradigms and excessively bureaucratic processes, efforts like the PSeries could spark dozens of CBES efforts throughout the U.S. The capacity built by such a tidal wave of groups would do much to engage citizens and improve the stewardship of our lands.

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Editors Biography

Flaxman Michael Flaxman is Assistant Professor of Urban Technologies and Information Systems in DUSP at MIT. His primary research interest is in the use of spatial simulation modeling in the planning and design of cities and regions. His work focuses on the development of tools for stakeholder-based planning which present evaluative models in context, using visual simulation. He has practiced GIS-based planning in 14 countries, including 1 year as a Fulbright fellow in Canada. Flaxman previously served as Industry Manager for Design at Environmental Systems Research Incorporated (ESRI), the world's largest maker of geographic information systems (GIS). Prior to joining ESRI, Michael was a Lecturer in Landscape Planning at Harvard's Graduate School of Design. Michael received his Doctorate in Design from Harvard in 2001, and holds a Masters in Community and Regional Planning from the University of Oregon, and a Bachelor's in Biology from Reed College.

Karl Herman A. Karl, retired U.S. Geological Survey scientist, holds a position of Affiliate Associate Professor with the University of New Hampshire Department of Natural Resources and Environment. He co-founded and was co-director of the MIT-USGS Science Impact Collaborative (MUSIC) from 2004 to 2010; during this time he held a faculty appointment as a Visiting Lecturer in the Department of Urban Studies and Planning at the Massachusetts Institute of Technology. Prior to becoming co-director of MUSIC he was Chief Scientist of the USGS Western Geographic Science Center. His current research focuses on climate change adaptation; in particular, adaptation at the local level through organic, grass roots movements. He is chair of the steering committee of the international Communities and Climate Change program, which is organized to investigate the role of collaborative processes involving stakeholders and scientists and technical experts in shaping the shared understanding of the socio-ecological system that seems necessary to cope with climate change. Karl serves on the board of the international Numerical Modeling and Policy Interface (NMPI) organization. Karl has been a visiting scientist at the Institute of Oceanographic Sciences, United Kingdom and

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a Senior Associate with the Harvard Law School Program on Negotiation. He has authored/co-authored about 200 articles, abstracts, book chapters, maps, and reports and has given numerous invited presentations; he has received several national awards and served on many committees to render scientific and strategic planning advice.

Scarlett Lynn Scarlett is a Visiting Scholar at Resources for the Future working on issues pertaining to climate change, ecosystem services, and landscape-scale conservation. She is an adjunct professor at Carnegie Mellon University. She was named the Zurich Financial Services visiting lecturer at the University of California, Bren School of Environmental Science and Management in October 2009. From 2005 to January 2009, she served as the Deputy Secretary and Chief Operating Officer of the U.S. Department of the Interior, a post she took on after 4 years as the Department's Assistant Secretary for Policy, Management and Budget. She served as Acting Secretary of the Department for 2 months in 2006. Ms. Scarlett initiated Interior's Cooperative Conservation Task Force in 2002. The Task Force, comprising all eight of Interior's bureaus, focused on building Interior Department capacity to engage in collaborative partnerships in landscape-scale and cross-boundary conservation. Scarlett also chaired the Department's Climate Change Task Force. She is a Fellow of the National Academy of Public Administration. Scarlett serves on the board of the American Hiking Society, the Continental Divide Trail Alliance, and the nonprofit environmental mediation organization RESOLVE. She is a trustee emeritus of the Udall Foundation. Her recent publication, "Large Landscape Conservation," co-authored with Matt McKinney and Dan Kemmis, was published by the Lincoln Institute in June 2010. She received her B.A. and M.A. in political science from the University of California, Santa Barbara, where she also completed her Ph.D. coursework and exams in political science.

Vargas-Moreno Vargas-Moreno is a research scientist and lecturer at the MIT Department of Urban Studies and Planning at the Massachusetts Institute of Technology (MIT). His current research is concentrated in the analysis and planning of regional landscape-scale systems under climate change. In particular, he is investigating transdisciplinary research approaches for the Department of the Interior exploring the impacts of climate change and rapid land use change in the Greater Everglades Ecosystem Strategic Habitat Conservation Initiatives. His prior research efforts have been concentrated on the formulation, analysis and visualization of spatially explicit alternative scenarios for development and conservation in highly contested landscapes using Geographic Information Systems and Technologies and Participatory-GIS.

Vargas-Moreno teaches graduate-level courses in environmental conservation and landscape planning methods and analysis in the Department of Urban Studies at MIT where he has also co-taught courses in simulation modeling of complex urban and environmental systems. He has served as the assisting director of the MIT-USGS Science Impact Collaborative and participated in several international research projects and consulted internationally in landscape, strategic and environmental planning. Vargas-Moreno has served as Lecturer at Department of Landscape Architecture of the Harvard Graduate School of Design, and as a Visiting Professor at several universities including the University of Costa Rica, the National Sun Yat-sen University Taiwan, the San Pablo CEU, Spain, and the Universita degli Studi di Pavoda, Italy. Mr. Vargas-Moreno serves as international moderator for the Open Forum on Participatory Geographic Information Systems and Technologies. Vargas-Moreno studied architecture and urbanism at University of Costa Rica, and obtain masters in doctoral degrees in landscape planning and ecology from Graduate School of Design, Harvard University. He is also an alumnus of the Sustainability Science Program at the Harvard Kennedy School.

Authors Biography

Abrami Dr. Géraldine Abrami is a research engineer at the French Institute for science, water and territory Cemagref. She is a modeller in the UMR G-EAU joint research unit and a member of the ComMod group. She has been developing conceptual models, multi-agent simulations and role-playing games as supporting tools for interdisciplinarity and implied research in several national and international projects.

Adamowski Jan Adamowski is an Assistant Professor in hydrology and water resources management in the Department of Bioresource Engineering at McGill University in Canada. He is also the Director of the Integrated Water Resources Management Program and the Associate Director of the Brace Centre for Water Resources Management at McGill. Dr. Adamowski's research interests include: modeling and forecasting of non-linear and non-stationary hydro-meteorological time series; hydro-meteorological trend detection and estimation; the urban heat island effect and its impact on water resources; collaborative adaptive management; and participatory modeling using coupled physical models and group built system dynamics models. He is on the Editorial Board of the Proceedings of the Institution of Civil Engineers: Engineering Sustainability, and is involved in research projects in Quebec, the US, Germany, Poland, Cyprus, India, Iran, Nigeria, Israel, and Cameroon, among other places. Prior to coming to McGill, Dr. Adamowski was a Post-doctoral Associate at the Massachusetts Institute of Technology in the Energy Initiative. He holds a BEng in Civil Engineering from the Royal Military College of Canada, an MPhil from Cambridge University and MIT, an MBA in International Business from four European universities, and a Ph.D. in Hydrology and Water Resources Management from Warsaw Technical University.

Barreteau Dr. Olivier Barreteau is senior water scientist at Cemagref, the French research institute on environmental and agricultural engineering, within joint research unit G-EAU in Montpellier, dedicated to water management and water uses. After a degree in hydrology, he did his Ph.D. within CIRAD, the French

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Research institute on agriculture and development, developing Agent Based simulations of cooperation patterns among farmers in Senegal River valley irrigated systems. He moved to Cemagref in 1999, developing his skills on interdisciplinary issues about collaborative water management at small basin scales, being involved in supporting the implementation of collaborative water management plan in southern France basins. His research focuses on the development of tools and methods to support collective decision processes about water issues, including agent-based models and role-playing games. He is also now involved in projects comparing and assessing participatory modelling. He is founder member of the Companion Modeling network (http://www.commod.org), which aims at building upon various experiments of iterative use of simulation models to understand and/or support collaborative decision making processes in the field of renewable resources management.

Beratan Kathi K. Beratan is a Research Assistant Professor in the Department of Forestry and Environmental Resources at North Carolina State University. She received her Ph.D. in Geology in 1990 from the University of Southern California. Her background in sedimentary tectonics and remote sensing gave her a strong grounding in systems-based approaches to research on historically contingent phenomena. For the past decade, her research focus has been in the emerging field of Sustainability Science. This transdisciplinary research centers on practical and effective methods for addressing so-called “wicked” problems, societal challenges that emerge from countless interactions among numerous biophysical and human system elements and processes, inextricably interlinked in complex social-ecological systems. Her research and public scholarship address the basic question of how we can more effectively address challenges involving distributed decision responsibility, situations in which both the systems being managed and the management systems themselves are complex adaptive systems. Using an “action research” approach, she is exploring the human dynamics of decision making in the public sector, and how effective design of information and of interactive processes can facilitate cooperative inquiry and coordinated decision making.

Carson Robert Carson is the Water Quality Program Manager of the Tomales Bay Watershed Council. He holds a M.S. in Ecology and Conservation Biology from Columbia University.

Clark Susan Clark is Joseph F. Cullman 3rd Adjunct Professor of Wildlife Ecology and Policy Sciences at Yale University. Professor Clark’s primary goal in her research and teaching is to improve conservation of species and ecosystems at professional, scientific, organizational, and policy levels. She has conducted field ecological and behavioral research on 35 mammals and other species. She is interested in natural resource policy and management and has conducted research and applied projects, for example, in the Greater Yellowstone Ecosystem to develop ecosystem management policy and in Australia to evaluate endangered species policy (most recently for koalas). She is currently researching conservation policy in Central

America. Her work involves building case studies, evaluating policies and programs, helping organizations to incorporate reliable science into management, helping students develop proficiency in the policy sciences method of research and problem solving, and working with a wide range of groups to improve conservation problem solving through workshops and other analytic exercises. She has worked in North America, Australia, Asia, and Central America. Recent books include Averting Extinction: Reconstructing Endangered Species Recovery (1997), Carnivores in Ecosystems: The Yellowstone Experience (1999, co-edited), and Foundations of Natural Resources Policy and Management (2000, co-edited). She is a fellow of Pierson College and has an appointment at the Institution for Social and Policy Studies.

Curtin Charles G. Curtin has 20 years experience designing and implementing long-term, large-scale conservation science examining the role of environmental change, and the interaction of people with the environment in marine systems and arid and semi-arid landscapes in the US and Mexico, East Africa, and the Middle East. Complementary work has focused on the redesign of the socio-ecologic institutions to develop and sustain durable conservation, science, and policy in the face of environmental change. A key focus being the use of science as a community-building tool to both inform and empower local communities and conserve the landscapes they inhabit. Served as consultant to organizations ranging from UNESCO to the rancher-led Malpai Borderlands Group while working to develop cross-cultural partnerships between East African and North American pastoralists, and US and Middle Eastern conservationists. He currently is developing place-based projects on ecosystem recovery in coastal Maine of which the paper here is a part. These ideas are part of a forth-coming book for Island Press on collaborative resource management and the conservation of large, open systems. He is currently a professor of Environmental Studies at Antioch University, New England and has recently founded and directs the North Island Science Collaborative on North Haven Island, Maine.

Daré William Daré is a sociologist at the GREEN (renewable resources and environment management) research unit of CIRAD. Since 1997, his research deal with the analysis of social change produced by the importation of technical or organisational innovations in social systems and their natural resources management. The innovations considered are for example, the building of irrigated schemes that modifies communities' rules on water allocation, the implementation of participatory principles in land use management or the translation in rural policies of the ecosystem services concept. His work is specially focused on a participatory modelling approach called ComMod (Companion Modelling approach) designed to strengthen the adaptive management capacity of communities through integrative collaborative modelling and simulation. He has been involved in several projects implementing this approach to address water and land-use management issues from local to international level in Africa and in Reunion Island.

Dechy Nicolas Dechy is a Generalist Engineer graduated in 1999 in Ecole des Mines de Douai (France), specialized in environment and industrial risks. He worked as a consultant for 2 years for industrial companies in France in risk analysis and safety studies, pollutants and toxic release modeling, environment impact studies, health impact studies, soil pollution studies, regulation compliance auditing. He worked for 10 years at INERIS (the national French Institute for environmental safety) in the field of process industry (petrochemical plants, pipelines, hydrogen transportation, tunnel), to support technically the French Environment, now, Sustainable Development Ministry, train inspectors, conduct research programs (French and EU) and provide consulting services to industrials. His main fields of interest were accident investigations, learning from experience, from technical to human and organizational factors, land use planning, governance, accident statistics, emergency response, security, risk analysis and safety studies. He was a member of the emergency technical support unit from INERIS for 7 years to support decision makers in crisis management situations. He conducted several investigations for the Ministry in particular the Toulouse disaster public enquiry. He has been chairman of the European Safety Reliability and Data Association (ESReDA) Working Group on Accident Investigation in 2006–2008. He published several articles on these subjects and collective books. He works now at IRSN (the national French Institute for nuclear safety and environmental radioprotection).

Dell Rebecca Dell is a doctoral candidate in physical oceanography at the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution. Her research focuses on the role of the ocean bottom topography in the movement of water, salt, and energy in the deep ocean. Her research has taken her to sea on two research cruises, both of which featured hurricane-force winds. Outside of her research, she has a strong interest in climate and energy policy. She organizes the MIT Energy Club Discussion Series, a regular round-table that provides members of the energy community with an informal forum to ask questions and share knowledge on a variety topics in energy. She also organized a photographic exhibition for the MIT Energy Conference, was an intern at the World Meteorological Organization in Geneva, Switzerland, and a delegate to the meeting of the UN Framework Convention on Climate Change in 2010. She also loves to sail and has a black belt in Taekwon Do.

Douglas Ellen Douglas is an Assistant Professor in the Department of Environmental, Earth and Ocean Sciences (EEOS) at University of Massachusetts-Boston. She is an expert in statistical hydrology and Principal Investigator of a NOAA/CPO/SARP-Coasts grant on environmental justice and climate change.

Du Toit Derick du Toit is a South African who studied Natural Sciences at the University of the Witwatersrand and specialising in Ecology. He holds postgraduate degree in evolutionary ecology and a higher diploma in science education. He specialises in environmental learning and also holds a Masters in environmental education from Rhodes University, South Africa. Derick has worked on education reform in both Namibia and South Africa. He has worked as a technical advisor to both Departments of Education and is author of 14 books for teachers. He currently works with the Association for Water and Rural Development (AWARD) in South Africa as project manager.

Enrici Ashley Enrici received her Master's in Anthropology from the University of Maryland, College Park. She is currently attending the University of Maryland as a doctoral student in the Geography Department. Her research to date has included an Ecosystem Based Management project with Maryland Sea Grant for Chesapeake Bay, and is now focused on environmental justice and climate change.

Ferrand Dr. Nils Ferrand is senior researcher at Cemagref, the French public research institute for environmental engineering, within the Water Management & Actors lab in Montpellier. His research themes are group decision support, public participation, participatory modelling, games and multi-agent systems. He has designed or participated into 10 European projects and more than 25 national projects, and has started one R&D company. He has more than 50 publications and book chapters. He graduated from Ecole Normale Supérieure de Cachan in applied physics, and also as Water and Forest Engineer, he has a MSc in math of Ecole Polytechnique and Univ. Paris Dauphine, and a Ph.D. in Computer Sciences from Université Joseph Fourier (Grenoble).

Garin Dr. Patrice Garin has 26 years experience as senior agronomist and geographer on farming systems and integrated water resources management. At present, he is the Director of a Joint Research Unit called "Water Management, Actors and Uses" (UMR G-EAU) at Cemagref Montpellier. His research focuses on the analysis of the interactions between land tenure and farmers' attitudes and strategies in participatory processes related to water management, mainly in irrigated areas.

Hammitt Sarah Hammitt was an intern with the MIT-USGS Science Impact Collaborative in the Department of Urban Studies and Planning at the Massachusetts Institute of Technology. She graduated from MIT with a Master of City Planning degree. She is a graduate of Princeton University.

Hogendoorn Daniel Hogendoorn is a political scientist, working at the University of Amsterdam. He is currently focused on nego tiated governance and public disputes.

Ibrahim Hauwa Ibrahim[1] is currently a Visiting Lecturer in the Women's Studies in Religion Program at the Harvard University Divinity School. In 2007, the Dutch government appointed her the EU Ambassador for EU Biogas for a Better Life: An African Initiative. She has been a champion for women's rights under Sharia law and her experiences are chronicled in a forthcoming book: *Practicing Law in Shariah Courts: Seven Strategies*. Ibrahim holds degrees in law and international

[1] http://www.google.com/search?hl=en&q=hauwa+ibrahim&aq=0&oq=Hauwa

diplomacy. She was awarded an honorary Doctorate of Philosophy by Carl von Ossietzky University in 2010 and an Honorary Doctorate in Human Letters by Godwin University College in 2006. She has received many awards that include Human Rights Award, Cavaliere al Merito della Repubblica Italiana, Sakharov Price for Freedom of Thought by the European Union Parliament, and Margaret Brent Women Lawyers of Achievement Award Awarded by the American Bar Association, Commission on Women in the Profession. Hauwa Ibrahim is an Honorary Citizen, City of Paris, France.

Kent Jim Kent is a global community organizer with extensive experience in successfully implementing bottom-up change processes based on informal systems. He is President of the JKA Group which has three enterprises: James Kent Associates, a public policy consulting firm; Center for Social Ecology and Public Policy, a non-profit that builds public policy from social ecological concepts; and Natural Borders, a human geographic mapping company. Jim has presented at hundreds of universities, policy forums, and conferences focusing on bio-social ecosystems, national environmental policy, policy formation and implementation, culture-based enterprise development and citizen-based collaboration. He has a Juris Doctors in Law and a Masters of Arts in Sociology.

King Neysa King is the program coordinator for the Tomales Bay Watershed Council. She holds a M.S. in Environmental Science from the University of Montana, Missoula, where she developed A Citizen's Guide to Watershed Conservation. She also helped draft the Tomales Bay Watershed Stewardship Plan: A Framework for Action.

Kirshen Dr. Paul Kirshen is Research Leader in climate change adaptation at Battelle Memorial Institute and also Adjunct Professor at Tufts University. With a background in Civil and Environmental Engineering, he does research and consulting at the local, regional and global scales on climate change impacts and adaptation, and also integrated water resources management. He is a Lead Author for the IPCC Fifth Assessment Report and also serves on several nation and local adaptation committees.

Kuhl Laura Kuhl is a master's candidate at the Fletcher School of Law and Diplomacy at Tufts University where she is studying International Environmental Policy, Development Economics and Human Security. She is also a student is the Water: Systems, Science and Society program at Tufts. Her research has focused on climate change adaptation and flooding in Honduras, as well as adaptation and environmental justice communities in Boston. Her master's thesis, entitled "From a Culture of Disaster Response to a Culture of Adaptation: Climate Change and Flooding in Honduras," is based on extensive fieldwork in Honduras and utilizes a "building block" approach to analyze a transition to adaptation. Her thesis explores potential elements for an adaptation strategy across scales: from the household level to the international negotiations, arguing that each component is necessary for a robust strategy. Before coming to Fletcher, Laura worked as a research assistant on risk communication and shared decision-making in the medical field. She received her undergraduate degree in Environmental Studies and Anthropology from Middlebury College, where her thesis research examined community dynamics and coastal management in Ecuador. Her research interests include climate change adaptation, sustainable development diplomacy, international development and water issues.

Laws David Laws is Associate Professor of Political Science at the University of Amsterdam and Director of the Amsterdam Centre for Conflict Studies. His current research focuses on reframing in the practical negotiation of urban and environmental policy.

Light Stephen S. Light is currently an adjunct faculty in the Integrated Water Resources Management Program McGill University conducting research into the implication of advances in dynamical systems, synergy and self organization theory on water resources problem solving. Receiving his doctorate at the University of Michigan, Ann Arbor, Light has worked on science and policy issues and exigencies in many largest-scale eco-regions: the Everglades, Coastal Louisiana, the Mississippi and Missouri River basins, the Great Lakes, the Sacramento River and Bay/Delta, the Middle Rio Grande and the Columbia River. Other ecologically sensitive areas of work include the Greater Yellowstone Ecosystem, Northern Hardwood-Conifer Forest, the Sierra Nevada and plateau region of Northwest Colorado, and the Galicia and Polesia forested-wetland regions, Poland.

Lividikou Dessie Lividikou studied political science at the University of Amsterdam. She is currently working as a policy advisor at the Province North-Holland in the field of climate, sustainable energy and sustainable development.

Marcel Frédéric Marcel Graduate of the Technological University of Compiegne, where he earned his degree in Mechanical Engineering, acoustical and industrial vibrations specialization, Frederic Marcel is, since April 2007, the Manager of General Services of the National Institute for Industrial Environment and Risks. He is responsible for the deployment of the Viability Development Program. Frédéric Marcel began his career in 1979 at CERCHAR as a Chief Engineer and a Project Leader at the Industrial Acoustic Laboratory. Before joining the General Services Division, he was for 8 years the Assistant Director at the Management of Chronic Risks Department. Frédéric Marcel developed an expertise in the field of risk communications due to his involvement on the PERPLEX project (with the collaboration of IRSN, AFSSA, INERIS, InVS, INRA, ADEME, IFEN and with the support of Cesem opinion) about a comparative study of risks perception by the public and by the experts. From 2005 to 2007, he belonged to the Working group AFSSET "Legionella – CNPE": Evaluation of the medical risks related to the proliferations of *Legionella* in the water of the cooling towers of the nuclear centers of electric production of EdF. Among other projects, he was involved in National Support Mission at the time of Legionnaire's Disease epidemic in Pas-de-Calais region in November 2003. Frédéric Marcel took part from 1980 to 2006 in the drafting of Book Process and many others publications.

Matso Kalle Matso Originally trained as a journalist and then as a marine ecologist, Kalle has spent the last 8 years trying to understand how federal science agencies can more effectively support the generation of new knowledge that can be applied to societal problems in a timely manner. Currently, he helps run the NERRS Science Collaborative, a partnership between the University of New Hampshire (UNH) and the National Oceanic Atmospheric Administration (NOAA). Prior to that, he helped run the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET). Kalle received his BA in English from The Colorado College in 1989 and his MS in Natural Resources from UNH in 2000. He is currently working on his Ph.D. at UNH, and hopes to be done by 2012.

Mattson David Mattson is a Research Wildlife Biologist with the U.S. Geological Survey stationed at its' Colorado Plateau Research Station in Flagstaff, Arizona. David received degrees in Forest Resource Management and Forest Ecology and a doctorate in Wildlife Resource Management from the University of Idaho. Dr. Mattson has studied large carnivores for the last 24 years, focusing on puma ecology and human-puma interactions in Arizona, and the conservation and behavioral ecology of grizzly bears in the Yellowstone ecosystem of Wyoming, Montana, and Idaho. He spent 14 years intensively studying grizzly bear foraging behavior and diet as well as ecological relations of foods the bears ate. These studies revealed details about a broad spectrum of bear behaviors, including their bedding, use of rub trees, consumption of dirt and earthworms, exploitation of red squirrels, pocket gophers, and meadow mice, and predation on elk, moose, and trout. More recently, Dr. Mattson has focused on conservation issues and broad-scale evaluations of habitat conditions. These studies have broached not only the details of human-large carnivore interactions, but also the social, political, and organizational dynamics that shape the policies and practices of carnivore conservation programs. His work has been featured in the journal Science and has been widely presented, including papers in Ecology, Conservation Biology, Biological Conservation, The Journal of Wildlife Management, and the Journal of Mammalogy, and invited talks at the Smithsonian, American Museum of Natural History, the American Institute of Biological Sciences, and International Conferences on Bear Research and Management.

Merad Merard Myriam is a Civil engineer (Ecole Nationale des Travaux Publics d'Alger). She obtained a Master of Business Administration (MBA) (ISG Alger and IEFSI (Groupe EDHEC France)) in 1999, a diplomat (DEA) in scientific methods in management science (operational research and decision aid) in 2000 and a Ph.D. in Management Sciences (Decision-making) in 2003 (Dauphine university). Her fields of expertise are risk assessment, management and governance, decision Analysis, human and organizational factors in safety, land use planning and sustainable development. She has joined INERIS in 1999. INERIS is a national public institute of expertise, in the field of environment and technological risk prevention, under the supervision of the French Ministry of Environment, territories and sustainable development. From 1999 to 2003, she was in charge of developing methodologies to prevent risks of subsidence and collapse due to mining activities (ex. Mining Risk Prevention Plans) at the Soil and Sub-soil Division. In 2003, she joined the Accidental Risks Division of the Institute. Between 2003 and 2008, she contributed to European programs in risk governance (Trustnet-in-Action, STARC, SAPHIR, …) and to research programs in the field of Technological Risk Prevention (ex. Acceptrisk). The general objectives of these programs were, in one hand to contribute to a more inclusive risk governance in France and, in an other hand, to improve the actual practices in risk prevention by developing methodologies using expert-judgment and decision aid tools. From 2005–2008, she was the head of "Societal Risk Management" and "Governance, human and Organizational factors" research groups at INERIS. In 2009, she was nominated as a sustainable development delegate at INERIS where she was asked to define the politic, the strategy and the Sustainable development action plan for the Institute. In October 2010, she will chair for the French Ministry of Environment and at a national level and for a period of 2 years a working group on sustainable development governance within public institutions and establishment. Myriam Merad was a member of the executive committee of the SRA-Europe. She and is at present member of the Scientific and Technical Commission of CEMAGREF and chairman or co-chairman of different working groups within Institut de Maitrise des Risques (IMdR), European Safety. Reliability and Data Association (ESREDA) and Association Française des Ingénieurs et Tehniciens de l'Environnement (AFITE).

McVicker Gary McVicker retired from a 34-year career with a federal natural resource agency in 2001. Gary received a B.S. degree in rangeland ecology from New Mexico State University in 1965. During his career he served in a variety of staff and managerial positions, including area manager, associate district manager, district manager, and deputy state director, working at all organizational levels, including Washington, DC. During the last 8 years of his career he worked extensively within his own agency, as well as others, developing and promoting many of the concepts contained in this chapter. He now lives in Colorado where he writes and does traditional large format black and white landscape photography.

Mosher Trannon Mosher is originally from Chapel Hill, NC, where he attended Carolina Friends School for his k-12 education. After graduating high school in 2001, Trannon moved to Boulder, CO, where received a B.A. in dance and a B.S. in aerospace engineering from the University of Colorado in 2006. Taking some time off between undergraduate and graduate school, Trannon through-hiked the Appalachian Trail in the latter half of 2006 and then moved to Reno, NV, to be with his now Fiancé. Trannon returned to the east coast in 2008 to attend MIT, where he had the privilege of working with Professor Karl along-side other graduate students on this material. After receiving his S.M. in aeronautics and astronautics from MIT in 2010, Trannon moved back to Reno where he is now a Data Modeling Analyst at a real-estate valuation company, Clear Capital. Trannon is extremely grateful for the opportunity to work on projects with so many talented and caring people throughout his education, especially on some of today's most pressing issues such as global climate change and its impact on socio-ecological systems.

Navarro Bridget Navarro is a graduate student in the Department of Civil and Environmental Engineering at the Massachusetts Institute of Technology. She is a graduate of the University of California, Los Angeles.

Paolisso Michael Paolisso is an Associate Professor and Director of Graduate Studies in the Department of Anthropology, University of Maryland, College Park. His research focuses on environmental and socio-cultural, including marine resource management, ecosystem restoration and management, fisheries, and climate change. He is conducting long-term fieldwork in Chesapeake Bay watershed, and has written extensively on culture and environment interactions for the Chesapeake Bay. Theoretically, he applies cognitive-cultural theory and method to the study of human dimensions and environment. He is a member of a number of scientific and policy advisory committees working on restoring the Chesapeake Bay. He teaches courses in environmental anthropology, qualitative methods, and quantitative anthropology.

Petersen Arthur Petersen is Chief Scientist of the PBL Netherlands Environmental Assessment Agency, Visiting Professor in the Centre for the Analysis of Time Series and the Grantham Research Institute on Climate Change and the Environment at the London School of Economics and Political Science (LSE) and Research Affiliate in the Political Economy & Technology Policy Program of the Center for International Studies at the Massachusetts Institute of Technology (MIT). He leads the PBL Netherlands Environmental Assessment Agency's efforts in the development and use of methodology for sustainability assessment and methodology for uncertainty assessment and communication, and is responsible for the agency's scientific quality assurance. Besides his professional jobs, he has been active within Pugwash, an organisation that brings together, from around the world, influential scholars and public figures concerned with reducing the danger of armed conflict and seeking cooperative solutions for global problems such as those related to poverty alleviation and protection of the environment.

Pileggi Mairi Pileggi serves the Tomales Bay Watershed Council as a community stakeholder. She has worked extensively with groups using collaborative decision-making models. Director of the Women & Gender Studies Program at Dominican University of California, she holds a Ph.D. in Communication.

Popova Albena Popova graduated her master degree in *Anthropology Department of Sofia University, Bulgaria.* She has been involved as a facilitator in the case studies of two European projects (*Aquastress****[1]****, PEER****[2]***). She was delegated to be a field assistant of *CIRAD and Cemagref, UMR G-EAU* in Sand River Catchment, South Africa to test a collaborative modelling and simulation framework called Wat-A-Game. She facilitated a study course on WAG in the *ECHEL-Eau Project closing conference* in Niamey, Niger in December 2009. She is assisting occasionally WAG development since mid-2009.

Pregler Charles Pregler has 38 years experience with Bureau of Land Management, the U.S. Forest Service and the Oklahoma Department of Wildlife Conservation as a biologist, trainer and community network specialist. He helped start and advised community-based stewardship groups and developed collaborative agency-citizen relationships in land use planning efforts in multiple states. From 1989 until his retirement in 2010 he was a training coordinator at the BLM National Training Center; from 1998 until 2010 he was Manager of the Partnership Series, a set of training courses and support services that fostered community-based stewardship throughout the western U.S. He now operates a private consulting firm that fosters community engagement in land stewardship. Contact information: 928-642-6090; charles@charlespreglerassociates.com

Preister Kevin Preister has worked for 30 years to foster citizen empowerment in areas ranging from urban redevelopment to water and recreation development. In the last several years, he has focused on natural resource management and has worked extensively with key federal agencies, notably the Bureau of Land Management, the U.S. Forest Service and others, to institutionalize management practices that reflect and build upon cultural practices and local routines. In both project work and through management training programs, both at home and abroad, Preister has assisted agencies in enhancing “productive harmony” between the human and physical environments by “working through the culture.” He received his doctorate in economic anthropology in 1994 from the University of California at Davis and resides in Ashland, Oregon. He currently directs the non-profit Center for Social Ecology and Public Policy and is adjunct faculty with Southern Oregon University.

Rising Megan Rising is a graduate of the Fletcher School of Law and Diplomacy where she studied international climate and energy policy and human security. She currently works as the Energy Outreach Coordinator for the Union of Concerned Scientists based in Cambridge, MA.

Souchère Dr. Véronique Souchère completed her Ph.D in agronomy in 1995 at the National Agronomical Institute of Paris. She is currently engaged as an agricultural engineer at the INRA Department of Science for Action and Development. Her research interests are soil erosion modelling using participatory approaches, geographic information systems, multi-agent systems and role playing games to promote collective watershed management of erosive runoff.

Towery Nate Deshmukh Towery is a doctoral student in the History, Anthropology, Science, Technology, and Society Program at the Massachusetts Institute of Technology. He received his AB in History of Science from Harvard University. His research interests are in science and technology policy, environmental policy, and renewable energy.

Werey Caty Werey is an engineer in water and environment sciences and Doctor in management sciences working in the joint research unit *Cemagref*-ENGEES GESTE "Territorial Management of Water and the Environment", Strasbourg, France. She has been working on asset management for water and sewer networks taking into account technical, socio-economical and management aspects (decision tools, impacts, actors…) since 1993. She is recently more focusing on management issues for integrated systems of urban waters. She studies socio-economic interactions between technical systems and urban planning decisions and on urban-rural interactions concerning water management.

Whitley Rich Whitley's experience as a government executive included confronting and resolving complex public policy issues in natural resource and energy development while working with diverse publics, the private sector and tribal interests. Rich was a leading proponent in federal government of citizen based stewardship by engaging communities in developing solutions that lead to healthy communities and healthy ecosystems. As a private consultant and Vice President of Real Life Training and Consulting Group he continues to help communities, organizations and tribal interests develop agreed on solutions to complex problems environmental, energy and community health issues. Rich is co-founder and Board member of the Small Diameter Collaborative that is successfully addressing long standing forest conflicts. He founded the Ashland Community Dialogue and is a founding member of the Rogue Valley Resiliency Fund, and Board member of the Southern Oregon Land Conservancy. Rich was recently elected President of the Board of the Southern Oregon Sustainable Business Network and serves on the Ashland School District Budget Committee.