Environmental Politics and Theory

ECOLOGY, SOILS, AND THE LEFT

An Ecosocial Approach

Salvatore Engel-Di Mauro

Ecology, Soils, and the Left

ENVIRONMENTAL POLITICS AND THEORY

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Ecology, Soils, and the Left: An Eco-Social Approach
By Salvatore Engel-Di Mauro

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ECOLOGY, SOILS, AND THE LEFT

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SERIES EDITOR'S FOREWORD

The Outcome of a Non-reductionist Ecosocial Inquiry: Advocating for a Political Soil Science and a Biophysical Leftist Critique of Capitalism

> *Soil science, as any other endeavor aiming to produce knowledge, cannot be regarded as independent of the social context in which it develops. Yet this is precisely how scientific or technical knowledge continues to be understood.*
>
> —Salvatore Engel-Di Mauro, *Ecology, Soils, and the Left,* Chapter 2

> *There is . . . little prospect in social theory for explaining how capitalist practices impact soils without learning about soils themselves . . . biophysical processes like soils are still too often treated as indistinguishable, unchanging backdrops in the explanatory frameworks of leftist scholarship.*
>
> —Salvatore Engel-Di Mauro, *Ecology, Soils, and the Left,* Chapter 6

As the Environmental Politics and Theory Series editor, it is my pleasure and honor to introduce readers to a new book in the series. Salvatore Engel-Di Mauro's path-breaking volume, *Ecology, Soils, and the Left: An Eco-social Approach,* is the fifth addition in this exciting young series. There are two comprehensive collections of studies of the globally significant problem of China's environmental crisis, and two innovative reflections on ecology and revolution, plus a feral theory of democracy and society (see the series's previous publications list). With Engel-Di Mauro's original and iconoclastic work that insightfully critiques both the biophysical science of soils (pedology) and leftist objections to capitalist society, the series has begun to fulfill its important mission to "collect, extend, and develop ideas from the burgeoning empirical and normative scholarship spanning many disciplines with a global perspective" (see series's mission statement).

Ecology, Soils, and the Left exemplifies this goal of the series with its prescribed "eco-social" approach by advocating the integration of the empirical scientific study of soils with leftist normative judgments of capitalism. This is accomplished with illuminating chapters on: soil properties, processes, overall quality, and degradation, and their socio-political implications and consequences (Chapters 1–4); the capitalist political nature of soil degradation (Chapter 5); leftist anti-capitalist yet flawed responses to soil degradation (Chapter 6); and, finally, a non-reductionist eco-social approach to environmental (specifically, soil) degradation recommended by the author (Chapter 7).

This is a remarkable book in several respects. Foremost is its main focus on soil. As the author observes (in Chapter 1): this may be the first book-length, socio-political treatment of the subject of soils—a claim that rings true in my reading experience as well. Even though "soil erosion" and "soil degradation" are commonly included in the litany of contemporary environmental problems listed by environmental scholars, along with such usual topics as water and air pollution, climate change, deforestation, biodiversity loss, acid rain, and so on, never before have eco-social (environmental *and* socio-political) details been presented about the biophysical processes of soils, yet soil is as important as clean water and air to human life and its environment. The author writes tellingly:

> Soils, as intrinsic parts of largely land-based ecosystems, provide us with the most basic means to sustain ourselves, including the purification and cycling of major sources of water . . . Most life on land would therefore not even exist without soils and, indeed, neither would we. We all depend on soils for our very survival because, at a minimum, we all have to drink water and eat.
>
> (Chapter 1)

The reader of Engel-Di Mauro's creative and informative book will learn what soils consist of and how they are formed, degraded, and recreated: the empirical inquiry of soil science. In the beginning chapters, what most of us grossly oversimplify as mere "dirt" is analyzed and expanded upon by the author in a provocative way; all readers (except pedology specialists) will be unable to see dirt/soils in an uninformed and reductionist manner. We can no longer separate soils and their study from politics and capitalist ideological interests after reading this compelling book. Engel-Di Mauro explains:

> The disinterest [in soils] seems the norm. For many in capitalist societies, including most leftists, soil stimulates no particular reaction. It may perhaps when it gets in the house, on our hands or clothes. Then, it is usually referred to as dirt or as a state of being soiled. And soiled is not usually something we aspire to become . . . [W]hen soil sticks to our bodies, clothes, or vehicles,

> the immediate reaction is not usually about how the physical integrity of a soil has been affected, but about cleanliness . . . . So perhaps it is because of the connotations of dirt and toil that soil is not a focus of much political ferment worldwide, like global warming is or tropical rainforest destruction used to be.

One surprise in this book exposes the hegemonic place that scientific reductionism of socio-politics holds in our modern capitalist society: how capitalist social and political relations in soil science affect allegedly "value-free" or "value-neutral," "objective" scientific determinations of soil quality. In the third chapter, we learn about the three major categories of the state of soil (soil quality): biological, physical, and chemical (see Chapter 3).[1] The condition of these components is used by soil scientists to determine soil quality and whether contamination or degradation of the soil has occurred. The crucial insight of this chapter, and the book as a whole, is contained in the following passage:

> The properties of a soil may develop without any influences from human interests, but soil evaluation is obviously done by people, who have ideas about how soils ought to be used, for what ends. These ideas come from interactions in society, not just from interactions with soils . . . Soil degradation must therefore include a study of the social context out of which it is defined.
>
> (Chapter 3)

This major point about the socio-political aspects of soil degradation judgments would itself establish the creative contribution of *Ecology, Soils, and the Left*. However, Engel-Di Mauro builds on this profound insight by making an important double-pronged critical appraisal of not only biophysical science in general and soil science in particular, but of leftist critiques of capitalism. He warns against committing the fallacy of a reductionist false dichotomy: falsely separating reality into the natural or the social. The upshot of Engel-Di Mauro's eco-social approach is that it exposes a modern, dualistic fallacy. There are not two categories here—the natural and the social (encompassing the political), but actually only one complex entity. The author's eco-social approach drives home the point that modern scientific thinking and capitalist ideology serve to separate/disconnect/alienate—to use a Marxist term—estrange humanity from nature. As a result, we must learn to recognize the natural is the social, and the social is the natural.

The heart of Engel-Di Mauro's profound and cogent argument is that both mainstream biophysical soil science and standard leftist critiques of capitalism are dualistic. Soil scientists ignore (consciously, or mostly unconsciously) the essential roles capitalism and the socio-political play in the assumed value-neutral scientific studies of the nature of soils, their quality and degradation. For example, "industrialized capital-intensive farming and the social system on which it rests" are assumed without critical scrutiny when soil quality improvement actions are being contemplated (Chapter 3):

> [T]he eco-social context of soil scientists is as important as the soil quality indicators measured. An end to a pretense of neutrality would be of scientific and wider social benefit, so as to promote an open discussion on political positions (e.g. about land use), the scope of science and the role of scientists relative to the state and the rest of society, among many other unspoken, yet underlying issues . . . .
>
> Ultimately, the issue of soil quality is a "social problem" . . . .
>
> (Chapter 3)

Also, leftist criticisms of capitalism omit (again, rarely consciously) the scientifically known qualities of soils, treating them as "backdrops" (see Chapter 6) to the leftists' arguments (if they are even considered at all).

All students of the environment and politics should take note of Engel-Di Mauro's insights regarding the methodological and epistemological errors of false dichotomy and resulting reductionism. These errors undermine our thinking, not just the research of scientists who study soils. The value of *Ecology, Soils, and the Left* is in its sweeping applicability. Environmental scientists must take into consideration the unavoidable, normative socio-political aspects of their study. They should not presume a socially isolated world of nature/the environment/soils characteristic of conventional scientific research. Socio-political factors must be made explicit and defended with reasoned evidence; this point is central to all scientific inquiry.

Engel-Di Mauro provides many illustrations of how soil scientists make basic methodological socio-political errors, exemplified by the definition of "marginal land," throughout the book. Similarly, the author argues that leftist critics who object to the environmentally deleterious impacts of capitalism—now worldwide under the tenets of neoliberalism—need to fill a huge gap in their socio-political studies with fuller biophysical understanding. Here the quote in Chapter 6 is most apt: "There is little prospect in social theory for explaining how capitalistic practices impact soils without learning about soils themselves".

Engel-Di Mauro proposes an inclusive and self-consciously complex combination of ecological science and socio-political analyses. He advises an eco-social approach to understanding environmental degradation in general and soil degradation in particular by outlining a general social theory of soil degradation and capitalist social relations in the final chapter of his work (Chapter 7). Researchers must conduct biophysical and social analyses simultaneously because the two are mutually constitutive; this ecosocial message of Engel-Di Mauro's book is expressed in a fundamental point made by Marx: "that people are part of nature and dialectically related to it in a differentiated unity" (Chapter 7).

What I have come to recognize as the fundamental cause of the global environmental crisis becomes abundantly clear in Engel-Di Mauro's *Ecology, Soils, and the Left*, and is, therefore, for me, a core teaching: the false and deleterious alienation of humankind from the biophysical environment. Throughout his book, the author shows instances where: (1) the scientific study of soils (or nature, in general) is conducted as if humans are unrelated to soils/nature, leading to pedological reductionism, and (2) leftist assessments of capitalist society are conducted as if capitalism and its social relations are independent of the natural world. These errors of separatist reductionism undermine both kinds of inquiries.

Engel-Di Mauro's text admirably identifies this common error in mainstream research of both fields. It also points the way to its remedy: the reconnection and the complexification of the natural and the social so that they constitute a more accurate whole. This requires the combined study of empirical (soil) science and social (political) analyses, an eco-social conceptualization: wherein the social is natural—humans and human society are a part of nature, not disconnected from it—and the natural is social—knowledge about nature, like all knowledge, "cannot be regarded as independent of the social context in which it develops" (see Chapter 2)—as Foucault has importantly taught us.

I close with a reference to a recent book that complements Engel-Di Mauro's path-breaking work perfectly because it also identifies the root cause of our current environmental crisis as the misplaced estrangement of humankind from nature requiring an "antidote . . . [that] challenges us to see Earth, each other, and ourselves with new eyes—the eyes of interdependence."[2] The author of the text quotes a reference to this separation from nature as a "wound."[3] Engel-Di Mauro's bold book proposes a diagnosis—reductionist separation—of this pernicious "wound" that has caused so much harm to our planet and its living inhabitants, and prescribes treatment in the form of inclusive and expansive eco-social interrelationships. For this significant accomplishment, we are much in his debt.

Joel Jay Kassiola

PREFACE

Any interest in studying biophysical process meets mostly with disinterest among leftists. Yet some of the major figures in leftist movements have been, for example, physical geographers (e.g., Élisée Reclus, Pyotr Kropotkin), physicists and/or mathematicians (e.g., Sofia Kovalevskaya, Cheikh Anta Diop), agronomists (e.g., Amilcar Cabral), paleontologists (e.g., Stephen Jay Gould), and physicians (e.g., Ernesto Che Guavara). At the same time, the biophysical sciences are rife with politics, the kind of politics that does not get acknowledged as politics and even somehow passes for objectivity. The biophysical sciences tend to be the sort of capitalism-friendly, classist, patriarchal, Eurocentric, racialized milieu that arguably makes many leftists want to leave or puts them off for good. Or at least it makes it understandable why so few leftists are attracted by biophysical science work. But, in spite of it all, there do exist biophysical scientists who are sympathetic if not leftist themselves. In fact it is, thanks to the likes of Ken Hewitt, David Schwartzman, Richard Levins, Judith Carney, Susannah Hecht, Michael Stocking, Fred Magdoff, Miguel Altieri, and Richard Lewontin that I have found inspiration to persist in the study of soils. It is a veritable shame that their role, contributions, and potential are so under-appreciated within the left.

The current situation is a most dismal one, one that undermines future possibilities for an egalitarian alternative to prevail. A revolution simply cannot be built by focusing only on organizing people, devising novel social theories, or studying what happens in society, although all such activity is fundamentally necessary. One cannot count on technocrats or scientists bound to liberal democratic outlooks for help in making a new society happen, especially when there is little to no awareness among most biophysical scientists about capitalist processes and certainly even less appreciation for the highly destructive nature of a capitalist mode of production. The biophysical sciences are instead replete with ready-made facile explanations for social horrors and environmental harms and with recipes to alleviate or resolve them that are aimed at finding all the culprits in the world except the ones with the most influence.

So it is out of long-standing enchantment and disappointment with the biophysical sciences and the left that this book has come about. It has taken a long time to figure out how to combine a fascination with soils with a commitment to struggles for egalitarianism. The process continues to be arduous, constantly threatened by reductionistic traps, and the hope is that the reader will approach the book in that light. It can also be overwhelming to attempt to keep up with social theory, critical empirical work on social processes, theories on biophysical dynamics, and the vast empirical work on soils. There are certainly few incentives to do so, institutionally and in any of the various strands of the left. But it seems that without an adequate grasp of a biophysical science, and the practical skills it can enable, any talk of revolution becomes rather vacuous. Biophysical scientists have proven historically to be largely subservient to the ruling regime of the day (and sometimes emphatically aligned with the ruling classes). It must become for the left a priority to develop supportive frameworks designed to cultivate interest and impart skills in the biophysical sciences. These could take the form of informal institutions, independently established and managed grassroots infrastructure such as soil and water analysis labs, and research agendas that explicitly meld political commitment with biophysical scientific work without collapsing one into the other. Even having time dedicated within leftist organizations to discuss the issue, to educate one another in one or another biophysical science, and to share and develop such knowledge and skills could help further the process of unifying the sciences, liberating them from the capitalist grip, and channel them toward much more socially sensitized and responsible ends. If this book contributes even to a very minor degree toward achieving such objectives, it will have been worthwhile writing it.

Saed
Neu Pfalz, in the Land of the Sepus

Acknowledgments

This work is a confluence of numerous conversations and discussions, at times surging with serendipitous chance occurrences. It is an effort that has involved the direct and indirect contributions of a very large number of people. Inevitably, I will fail to thank everyone who has helped me along the way and so I hope they will accept my apologies. First and foremost, I am profusely thankful to Deborah and Ezra Engel-Di Mauro, whose support and encouragement enabled me to have the time and to sustain the mental aptitude to research and write and, thanks to their prompting, to find more appropriate and clearer ways of expressing myself. Similarly, I am indebted to my mother, Graziella Menconi Di Mauro, and to Harold Engel, with whom I have shared innumerable conversations on leftist topics. Many thanks go to Pierpaolo Mudu for always finding a way to talk me through things and discern the positive in this and other endeavors.

I am very much grateful for the welcoming atmosphere, the patience, and the encouragement of Scarlet Neath, Brian O'Connor, and Robyn Curtis at Palgrave Macmillan. Without them, of course, this book would not have been possible at all. Discussions among comrades at *Capitalism Nature Socialism* have also been pivotal to developing many of the ideas expressed herein. In this, I would like to recognize especially Paul Bartlett, Leigh Brownhill, John Clark, David Correia, Maarten DeKadt, Nik Heynen, Joel Kovel, Mazen Labban, George Martin, Ariel Salleh, David Schwartzman, Erik Swyngedouw, and Eddie Yuen. John Clark, Nik Heynen, and Ben Wisner in particular have been a tremendous force in facilitating this project's fruition through their enthusiastic support. Many others have likewise contributed through insights, critiques, and suggestions, even if sometimes unknowingly. Among them are Harald Bauder, Hugo Blanco Galdos, David Butz, Karanja Carroll, Sutapa Chattopadhyay, Kanya D'Almeida, Daryl Dagesse, Sándor Hajdú, Ken Hewitt, Sándor Kurucz, Jenna Loyd, Attila Melegh, Paola Migliorini, Paul Robbins, Flavio Valdimir Rodríguez, Quincy Saul, Daniel Tanuro, and Kálmán Vörös. Equally important has been Peter Wissoker, who, while at

Cornell University Press in 2006, originally solicited my work on Gavin Bridge's recommendation and continued to be supportive despite my glacial writing pace. The manuscript has undergone many transformations since the first set of ideas that launched the endeavor, but without that initial push, this volume would simply not have come about. I must also give credit to Rick Schroeder, who eons ago advised me to pay particular attention to Piers Blaikie's 1985 volume, which is cited quite often in this work and has been a decisive early influence on me. As demonstrated by the many people contributing in one way or another to the making of this book, writing is a collective process and I find myself in the good fortune of being situated in the midst of a braided flow of insights.

CHAPTER 1

MUTED EVERYDAY DISASTERS

A most subtle scourge is menacing the world, the sort that threatens and deceives all at once. This is the scourge of soil degradation. Its sheer existence undermines many lives, yet it is tough to discern, shrouded as it is in tales of untold scarcities and dissembled as it is by a fog of recycled scarecrows. This shrouding and dissembling, the politics of soil degradation, is what amplifies the subtlety of its often gradual and nearly imperceptible nature. Yet the ambiguity belies its menacing power, which is juxtaposed with actually existing or potential devastation, with imponderables effaced by sensationalism. Paradoxically, many of those decrying both the inadequate attention to soils and their degradation contribute to perpetuating what they decry, for they decry not the social relations of power that undergird the scourge. On the other hand, when it comes to soils, leftists[1] have been mostly on the inattentive camp or have borrowed uncritically from the scarecrow-mongers. Traversing the fog and deciphering the tales requires research on biophysical processes, where leftists rarely tread, and critical appraisal of research on biophysical processes, where leftists have excelled. There are a number of incentives to undergo this double task of research and critique of research. One is to contribute to overcoming the reckless disinterest in and the overshadowing effects of scholarly fastidiousness over nuance and another is to resist the corollaries of depoliticizing environmental sensationalism (like catastrophism or "peak soil") and technocratic scientism (like blaming soil degradation on population growth).

The disinterest, though, seems the norm. For many in capitalist societies, including most leftists, soil stimulates no particular reaction. It may perhaps when it gets in the house, on our hands or clothes.

Then, it is usually referred to as dirt or as a state of being soiled. And soiled is not usually something one aspires to become. Referring to soil as dirt is perhaps unsurprising, given that large numbers of people are now hardly steeped in direct contact with soils as previous generations were. What is interesting is that soil becomes dirt—a disruptor of hygienic norms—precisely when it is detached from itself. Dirt is also soil that is out of place, in the mainstream imaginary. In this, lay or, more precisely, unsystematic understandings of dirt converge with scientific ones about soil displacement, at least superficially. There is awareness that something is wrong when soil is out of place. Yet when soil sticks to our bodies, clothes, or vehicles, the immediate reaction is not usually about how the physical integrity of a soil has been affected, but about cleanliness.

This in itself is not necessarily a capitalist phenomenon, but it feeds into it. The way soils are made perceptible to people involves connotations beyond something being dirty, out of place. A whole way of life is evoked by soils. Not so long ago, an overwhelming majority of people survived or thrived by living off the land, which is often used as a metonym for soil. Dependence on soils was a palpable, everyday, common experience, and remains so for a decreasing multitude worldwide. This other meaning of soil, as a source of sustenance, remains, even if less commonly acknowledged. But soil acquires negative symbolic value when most people's economic prospects are removed from its life-enabling contributions. Many leftists know this outcome all too well, as well as its social foundations, but are themselves largely distanced from many of our nonhuman sources of existence, like soils.

A statement in a recent special report on cities in *The Economist* even glorifies this historically socialized remoteness: "It was in the city that man was liberated from the tyranny of the soil" (The Economist 2007, 4). In such a worldview, with its not so accidentally sexist language, our connection to soils, standing in for the work of procuring food, is like a chain that can be and has been broken to humanity's benefit. By implication, living from the soil is like visiting a museum exhibiting life in the arduous, grimy agrarian past, from which the industrialized and urbanized have been freed. The hundreds of millions still living off the land deserve our pity and the utmost effort at their emancipation. The other hundreds of millions eking out an existence in the squalor of mega-cities should be considered the lucky beneficiaries of the progress urbanization offers. Let us praise our savior, the capitalist city! So perhaps it is because of its connotations of dirt and toil that soil is not a focus of much political ferment worldwide, like global warming is or tropical rainforest destruction used to be.

Extremists' delusions aside, our links to soils cannot be severed without compromising our existence. Soils, as intrinsic parts of largely land-based ecosystems, provide us with the most basic means to sustain ourselves, including the purification and cycling of major sources of water. Every year, they enable the proliferation of all sorts of organisms, many of them directly and indirectly crucial to our lives.[2] This is besides establishing the conditions for the human production of millions of tons of food and fiber. Most life on land would therefore not even exist without soils and, indeed, neither would we. We all depend on soils for our very survival because, at a minimum, we all have to drink water and eat. And without functioning soils, those basic resources are endangered. So, what a strange idea it is to celebrate freedom from something without which we die. In the kind of society in which I live, most people are so removed from the realities of what sustains life that they can delude themselves into thinking about freedom in terms of abandoning what we depend on. Such is the lived disconnect—the alienation, as Marx famously put it—between people in capitalist societies and key ecological processes from which they draw sustenance.

There is, then, an inescapable biophysical necessity that binds us to soils. Our being rests on ensuring that soils contribute to our benefit, like breathable air and drinkable water. But our ecologically contingent being is always also a function of what happens in society. The freedom alluded to by ideologues such as those represented in *The Economist* is the sort of freedom that excludes most people. As Mies and Shiva succinctly put it, "Freedom *within* the realm of necessity can be universalized to all; freedom *from* necessity can be available to only a few" (Mies and Shiva 1993, 8; italics in original). The notion of liberation from the tyranny of the soil is a worldview of the privileged, those in a position to consume massive quantities of resources from all over the planet, which means forcing most others in the world to labor so that a few may reap the greatest benefits from the use of soils. The privileged need not understand the necessary relationship between people and soils, except superficially (as when using soil erosion problems to kick people off the land) or when it matters to maintaining their own privileges.

Soil degradation processes are therefore mostly quieted disasters in present-day capitalist societies, but not catastrophic in the sense envisaged in much environmentalism, and largely misconstrued by soil scientists or experts with respect to their causation.[3] They are subtle scourges not just because they are usually difficult to sense (barring phenomena like landslides), but also because they have become socially downplayed if not altogether suppressed from the everyday. Soil degradation is the outcome of social relations that enable some to have the luxury of being unaware of soil degradation problems or to have the power of dictating when soils are degraded. It is the same outcome that compels many to have no access to soils or to use soils carelessly. These are, in other words, processes of alienation from soils by way of a historical development of both concrete, if not compulsory, distancing and ideological severance. Some soil scientists object to attitudes represented in *The Economist* and see them as resulting from detachment from nature.

> Paradoxically, even as our dependence on the soil has increased, most of us have become physically and emotionally detached from it. Many people in so-called "developed" countries spend their lives in the artificial environment of a city, insulated from direct exposure to nature, and some city-bred children may now assume as a matter of course that food originates in supermarkets. Detachment has bred ignorance, and out of ignorance has come the delusion that our civilization has risen above nature and has set itself free of nature's constraints.
>
> (Hillel 2008, 5)

If for the moment one can leave aside the in-itself alienating society–nature dichotomy in the notion of cities as "artificial environment," there is in these words a potential convergence with Marx's insights on capitalist alienation and therefore a possibility for critical sensibility. It is a possibility that is consistently dashed by scientists' own ideological tenets and political commitments to objectivist science, to neutralism in the face of oppressive social relations, and so forth. Soil scientists who discern the ecological repercussions of the contradictions of the society in which they live are the same who see only an undifferentiated humanity as the culprit, even as they are ostensibly capable of perceiving social differentiation (e.g., "developed" and "undeveloped" societies). Theirs is the self-exalting technocratic flipside of the same privileged or capitalistic worldview. In the technocratic version, the experts are the heroes who will save us ignorant masses from self-delusion and help save our "civilization" from the death throes of soil degradation. It is rare to find soils scientists with even minimal understanding that such contradictions are intrinsic to a capitalist mode of production (if they are even familiar with that term). This depicts a state of affairs that finds its corollary within ill-informed leftist anti-capitalist movements and writings, as will be discussed. The quiet scourge is therefore not just a wider social one. Real existing soil degradation problems may be made into quiet catastrophes by social means (including within the anti-capitalist left), but there is more to soil degradation than what happens in society.

Much of what unfolds in soils is difficult to sense because it is inaccessible until one digs. The surface of a soil often does not represent what goes on beneath, with the bustle of activities by innumerable and largely still unidentified micro-organisms and the constant movements and transformations, both gradual and immediate, of gases, water, and materials. The problem of not sensing all this is not just the result of detachment from nature, which is the only aspect most concerned soil scientists seem willing to consider. What soil scientists generally miss or fail to investigate (they are hardly alone in this) are the historical and current social relations that make such detachment possible and persistent—the forced expulsions of people from land on which they subsist, with massacres and genocides, misogynistic and racist violence, militarily forced displacement, colonization, and other forms of coercion that reverberate across generations. This is what fundamentally demarcates leftist analysis of soil degradation from that of technocrats. There is, however, an unfortunate propensity on the left to focus on the social relations at the expense of what soil scientists have excelled at studying, the soils themselves. Our interactions with soils are also related to what soils are and the way they develop independently of us. This latter aspect can be said of environmental degradation more broadly, since environmental change occurs also independently of people.

Stated otherwise, soil degradation is comprised of combined ecological processes, among which are social ones. They tend to be silent as a consequence of processes that are both social (e.g., ideological distancing) and biophysical (e.g., soil resilience). It is a tendency that is disrupted every now and then by changes in soils that are destructive to people. This can be illustrated by heavy metals contaminating crops when some key soil characteristics (like pH) change, crop failures abetted by declines in soil nutrient availability, or soil creep undermining housing structures. Changes in society bring about other possibilities to counter the tendency for soil degradation to be a quiet catastrophe. This happens when some organize their lives in ways that enable heightened awareness, such as through the introduction and spread of urban community gardens. It can also occur when ruling classes pursue policies that raise business or state dependence on agricultural exports. At such points, soil quality can even take center stage.

SOILS, HUMAN IMPACT, AND POLITICAL STRUGGLES

To illustrate the existence of the quiet (but occasionally and temporarily loud) scourge in the lived and imaginary worlds of capitalism, I do not have to venture far and I dare say neither does the reader. The town where I live is adorned by orchards, especially apple orchards, making for an inviting, seasonally verdant, and multicolored floral landscape. But adornments can deceive. The orchards in this place called New Paltz are the sort of managed woods that have been doused for decades with chlorinated biocides and associated heavy metals, leaving a long-lasting legacy of contamination of soils and possibly water. Each time there is an initiative to build a shopping mall, roadways, or housing complex, the specter of the past comes alive with fears of mobilizing dormant poisons or of discovering a life-menacing reality in what seems at first glance to be a safe, tranquil place (Heitzman, Smith, and Duffy 2011; Parisio et al. 2009; Steinberg 1995; Town of New Paltz 2010).

Recently, a large construction firm joined the local college administration to convince the local government to turn an old abandoned orchard into a college residence. Town hall meetings were convened to invite interested parties to voice concerns, as legally required, and various technical impact assessment reports were made available to the public. There is much at stake financially, for the construction company, the college administration, and the private consulting companies hired for the assessments and building process. Emphasis is laid, as typical of such public displays of capitalist democracy, on the great advantages that will be brought to students and faculty in securing housing close to the college and on the environmental benefits of reducing greenhouse gas emissions from car-dependent commuters. The problems of attracting more students, of housing availability, and of air pollution are all happily met by a single project.

But dark forces lurk below ground. According to one of the consulting firms' findings, the soil on which the residential area is to be built retains worrisome levels of 4,4 DDT and dieldrin, as well as high amounts of arsenic (Ecosystem Strategies, Inc. 2012). Aside from this, the overall assessment of the site was deemed positive, with reservations from a few local inhabitants and students, and in spite of concerns raised by a hydrogeology consultant about groundwater availability and quality (Miller Hydrologic Incorporated 2012). A new sewage treatment plant was part of the plan, even though one nearby already exists, and more water would be pumped from municipal water sources. The objections discussed were related to water supply and treatment issues, impacts on other species, drains on local government and property owners' finances (by way of payment of an amount to be agreed with the local government in lieu of taxes), the exclusion of poorer students who cannot afford the new lodging, among other social and ecological effects.

The soil contamination aspect exemplifies the politics of environmental issues. The moment one starts looking for and examine more closely the different social and ecological aspects involved in soil contamination, the clearer it is that it cannot be treated as solely a technical issue, as implied in what in the United States is termed "environmental impact assessment." In fact, the assessment, presented as a technical report, was hiding some disconcerting assumptions about what counts as relevant knowledge and even what kind of activities should be allowed on the premises. The impact assessment consultants biased the soil sampling toward minimum contaminant detectability, excluded most heavy metals from lab analysis, selected less stringent critical values for acceptable contaminant levels, and ignored some basic dust dispersal issues.

The soil sampling procedure was limited to the first 6–8 cm of depth and concentrated along the drip lines of the trees. This was presented as standard procedure, but it is nevertheless a most curious way of looking for information. Tree roots reach much greater depths than that and so create tunnels for potential contaminant percolation below the sampling depth. Trees are also sprayed with insecticides as they grow so that what is currently the drip line does not reflect all the drip lines of the past, as the tree was growing. Contaminant movement is hardly confined to drip from the top of a canopy. Contaminants can also descend along a tree stem and collect at the bottom of a tree, close to the trunk. These avenues of movement for contaminant-bearing water on and from trees and into soils are well known (Pritchett and Fisher 1987). Not only were entire areas systematically skipped from sampling, but tests only included arsenic, lead, and mercury, leaving out heavy metals like copper, which is often found in fungicides, often featured in the panoply of agrochemicals applied in orchards.

In the interpretive part of the analysis, the consultants conveniently omitted the much more stringent "Unrestricted NYSDEC SCO" standards, opting instead to include only the Residential version. This selectivity cannot but go unnoticed by the majority of locals, who are unfamiliar with such documentation or how to interpret it. But by using the critical limits set for residential land use, the consultants effectively imposed a policy decision on what kinds of activities would be permitted. For example, establishing a garden to grow food, which is of interest to many students, is foreclosed as an option. If the contaminant limits used had been for unrestricted use, the developer would be forced to decontaminate the site so as to enable other uses besides conventionally defined residential use, an official definition that also presumes that people do not grow food where they reside. In this manner, they were able to reassure the public that the levels of lead found on the site are to be regarded as safe.

Finally, the consultants considered contaminant-bearing dust heaved up through construction work as if it were innocuous to the health of future residents and as if it would remain largely within the building site. Their view of the health of future residents explicitly assumes that only adults would live in the housing units. This is a rather unlikely outcome, as both faculty and students may have children. Just as gratuitous is the assumption of adults having no sensitivity to the contaminants to which they could be exposed. For the dust diffusion aspect, there was no analysis of wind patterns to determine where exposure and accumulation risks could occur elsewhere in other areas. There was little basis for the consultants' assumption that contaminant-bearing dust will be confined to the project site.

This example of official practices in assessing environmental problems brings out many of the social and ecological issues that tend to be hidden from view in discussions about environmental degradation. By ensuring a largely positive outcome in the environmental impact assessment, such diligent misapplication of technical skill systematically narrowed the kind of information available for public discussion in favor of those whose interests were served by the residential construction project. Ostensibly, this could be interpreted as an example of science under the influence of local or regional capitalists. However, it is scientists themselves who are involved in producing knowledge on the environment and decisions over land use or over how to handle the negative long-term effects of past impacts are usually far from straightforward. Such decisions usually involve several competing bourgeois and allied interests (despotic or reformist) and sometimes even the influence of anti-capitalist dissidents (authoritarian or revolutionary). In this case, matters seemed to proceed favorably for the corporation, the college administration, and their allies until local land and business owners entered the fray and asserted their weight, conveying their displeasure with the potential tax exoneration for the construction firm. After at least three intense public deliberations, local government permission for the project was stalled, to the convergent relief of most local property owners and some anti-capitalist and reformist local activists. The struggle to expand college residences and tax-exempt profits continues, as does the drive to accumulate capital regardless of ecological consequences.

The context just described has its particularities, such as location along a formerly glaciated valley, seasonally high water tables due to proximity to a river, often stony soils, high topographical variability, a buried history of conquest, slavery, and genocide, the presence of wealthy multiple-property owners or land speculators, a predominance of reformist politics (not just environmental), a large number of artisans, a seasonal influx of thousands of students, no bombing raids from an imperial power, and so on. However, some of the basic processes involved in the struggle over land use and in the relationship between social and ecosystems can be extended to other places. Soil contamination issues may have been submerged as quickly as they surfaced in the debates over the construction of a college residence on a former orchard. Yet what persist are not only the amounts of different contaminants, which may ultimately be negligible relative to human health (so one hopes), but also the effects of soil properties and other environmental forces (including micro-organisms) on the potential mobility of those contaminants. This is aside from the local eco-social histories that led to the existence of an orchard and its abandonment in a certain part of town and to the industrial farming practices that resulted in effects still to be felt decades later. It is also in addition to the linkages the town has with other places, linkages that have brought about changes in local land use and environmental impact over time, such as the establishment and expansion of a college, the influx of real estate investments (including the above-cited construction firm), and the influence of environmental activism. This is by no means a one way process, since what happens in this town (called "village" in administration speak) can have larger-scale consequences, such as setting examples by officially accepting same-sex marriage or by affixing solar panels on municipal buildings. And all this is, finally, in addition to the environmental processes that extend beyond the area where the town is located and that are also affected by now largely capitalist human impact, like regional and global changes in air circulation, leading to differences in the reach of human-induced acid rain from elsewhere and to more or less precipitation or higher and lower temperatures at different times of year. These are far-reaching forces that shape the fate of soil contaminants through changes in soil pH, organic matter (OM) decomposition rates, related microbial activities, and other processes affecting the fate of locally introduced soil contaminants.

THE PURPOSE, CONTRIBUTION, AND ORGANIZATION OF THIS WORK

The above example centered on a political conflict over land use in New Paltz could be considered an application of a framework whereby aspects of both social and wider ecological processes (e.g., soil contamination) are supposed to be considered and studied in explaining change in people-environment relations, referred to here as ecosocial change (for reasons explained in the concluding chapter). The intertwining of social and biophysical study remains rare. Whereas mainstream capitalism-friendly science largely reflects lack of awareness if not tacit acceptance of relations of power and institutionalized divisions of scientific labor, within critical and leftist scholarship, the problem seems to originate in a combination of acceptance of limits imposed by prevailing knowledge production divisions (e.g., social and natural sciences) and flaws in the overall approach related to shallow understandings of biophysical processes.

This book makes four contributions to leftist and critical scholarship as well as soil science. One is a critical appraisal and revision of soil science fundamentals from an ecosocial perspective developed out of existing leftist and critical works. Another is to show a way of integrating conventional, positivist scientific work with the formulation of alternative ways of defining, analyzing, and explaining soils. This includes reconceptualizing soil quality and degradation in such a way as to account for both social relations of domination, soil dynamics, and wider ecological processes. A third contribution is to expand and update previous critical analyses to expose the capitalist ideology underpinning much of soil science, including the ways in which such ideology permeates understandings of soils and explanations of soil degradation. To my knowledge, this is also the first effort at bringing together leftist and critical studies on soil degradation. Finally, in reviewing leftist and critical scholarship on soils, I demonstrate how a lack of involvement in or attentiveness to soils research debilitates some of the major leftist approaches and theories on environmental degradation.

A lack of direct study of the biophysical processes has resulted in sometimes flawed theorization regarding people-environment relations and has contributed to ineffective challenge to capitalist mystifications in the biophysical sciences. Chapter 2 provides an introduction to soil processes and major characteristics to explore the simultaneously nonhuman and social basis of producing soils knowledge. The limits and erroneous assumptions prevalent in soil science on these issues are highlighted. Chapter 3 constitutes a critical overview of the concept and deployment of soil quality, which underlies notions of soil degradation. An alternative, socially contextualizing way of defining soil quality is introduced. Chapter 4 is an investigation into the problematic nature of defining soil degradation, which follows from faulty understandings of soil quality, and of the actual information available to determine the extent and severity of soil degradation worldwide. It turns out that claims of global soil degradation rest on geographically very uneven quality and reliability of evidence and that, conceptually, soil degradation research is fraught with capitalist assumptions. Similar problems exist with claims about soil erosion and these are brought to bear in refuting the "peak soil" thesis and related arguments. Rather than making unsupportable arguments, all concerned about soil degradation should clamor for greater research funding for worldwide and more appropriate data collection and analysis. However, such research must be contextualized to make sense of soil degradation. To this end, an alternative is offered on the basis of existing critical works available since the late 1970s. Tenuously supported claims of worldwide soil degradation are also used in soil degradation theories, addressed in Chapter 5, to argue mainly for population growth or mismanagement as primary drivers or to warn of civilization collapse. The civilizationist thesis is challenged along with populationist and mismanagement theories on the basis of both faulty evidence and capitalist, if not racist biases. Regrettably, some leftist approaches are contributing to reinforcing such technocratic and supremacist views. In Chapter 6, I summarize and evaluate the insightful critical and leftist contributions to countering mainstream theories. After discussing their importance and limitations (mainly in failing to address capitalist relations), I critique certain leftist currents, mainly eco-Marxist and world-systems, that exhibit sometimes fatal errors because of insufficient attention to biophysical processes or research. Examples are also discussed of how lack of attention to soils research leads to undermining entire theories. Particular attention is given to leftists' assumptions about soils as homogeneous, exhausted, or actants.

In the concluding chapter, I describe the foundations of an ecosocial perspective (one that locates the social in the ecological while addressing the social basis of knowledge production) and how this general approach assists in reinterpreting soil degradation, avoiding social reductionism and depoliticizing perspectives. The above-described example in New Paltz describes the multiple-scaled interconnections and reciprocally constitutive processes between social relations and soil dynamics that inform such an ecosocial framework. As discussed in the concluding chapter, these interconnections are not necessarily direct and their relative intensities depend on several factors: (1) the local ecological context, including soil type; (2) social and ecological/soil histories; (3) interconnections with other social systems; and (4) the effects of wider environmental processes. A general theory is offered regarding the relationship between soil degradation and the capitalist mode of production. The main argument is that the soil-destructive tendencies of capitalist relations must not be confused for any necessarily terminal devastation because, among other reasons, soils entail far more numerous processes than social relations alone. This explanatory approach is a way to challenge soil (or biophysical) scientists to consider social relations seriously and leftist scholars on environmental degradation to become more involved in producing knowledge about biophysical processes, rather than continue as largely passive users thereof.

CHAPTER 2

SOILS AND THEIR CLASSIFICATION: ECOLOGICAL PROCESSES AND SOCIAL STRUGGLES

Prior to discussing soil quality or degradation, it is helpful to examine, even if to a limited extent, what soils are and how they change. The issue of defining soils is complicated in part because soils are assemblages of different materials and organisms that are often independent of one another, even as they form a whole. Soils usually grade seamlessly into each other and their boundaries can be ambiguous. Another source of difficulty is that field observation is frequently contingent on the degree to which one can dig to expose soils. Even then, if one looks attentively, the staggering complexity of the material tends to thwart any straightforward definition (Arnold and Eswaran 2003, 29; Schaetzl and Anderson 2005, 3).

There is no single way of identifying phenomena as soils because prevailing understandings of soils are also context dependent. Work in ethnopedology[1] (e.g., Barrera-Bassols and Zinck 2003; Landa and Feller 2010; Sandor and Furbee 1996; Steiner et al. 2009; WinklerPrins and Sandor 2003), environmental history (Showers 2006, 126–131), political ecology (Zimmerer 1994), and, rarely, leftist research (Bradley 1983; Engel-Di Mauro 2003) demonstrates variety to be the norm. Most who recognize the socially contingent meaning of soils are nevertheless constrained by tacit adherence to a capitalist framework. This can be seen in functionalistic notions, dividing meanings according to whether someone is a gardener, an engineer, or something else (e.g., Gobat, Aragno, and Matthey 2004, 11; Schaetzl and Anderson 2005, 9; Sprecher 2001, 3), or in their technocratic approach, whereby definitions are given without any qualifications as to social context (e.g., Gerrard 2000; Hillel 1991; Johnson, Domier, and Johnson 2005). Otherwise, soil knowledge is reduced to catalogue-like descriptions (e.g., Eswaran et al. 2003; Krupenikov 1981; Warkentin 2006; Yaalon and Berkowicz 1997), with little appreciation for historical change and the intra- and intersocietal power relations in knowledge production or meaning construction (Engel-Di Mauro 2006; 2012a). These latter kinds of analyses remain largely ignored in ethnopedology and soil science history, pervaded as they are by assumptions of community homogeneity and an oppression-free world.

Nevertheless, studies in ethnopedology and soil science history point to overlap in the content of such diverse understandings, which convinces me that soil knowledge systems should be viewed as largely complementary. This is even more so when formal science is distinguished from other forms of knowledge (e.g., Eswaran et al. 2003; WinklerPrins and Sandor 2003). Formal, biophysical sciences usually focus on a limited scope of processes related to a specific subject of study and contribute systematicity and generalizability about that specific subject. Wider cultural understandings integrate observations and explanations about subjects like soils into an overarching worldview linked to concrete soil-impacting practices, usually within more restricted ecological contexts, and the large array of factors confronted by people living off soils stimulate the development of insights often missed by outsider scientists (Brookfield 2001, 80–82; Stocking 2003).

There is then complementarity, but also difference because (a) "natural science" and "local knowledge" systems are part of and/or have derived from multiple cultural frameworks, with a recent imposition and predominance of capitalist Eurocentric perspectives (see Federici 1995; Needham 1954; Van Sertima 1988), and (b) nonhuman phenomena occur independently of humans' understandings of them. The processes involved in what is regarded as scientific knowledge are not co-extensive with those regarded as local or traditional knowledge because the former is a product of many cultural traditions and so can traverse and be accommodated into many cultures. For example, the establishment of criteria for identifying and distinguishing soils is a process common to many cultural traditions and the distinctions made have much correspondence with those laid out through institutional scientific versions (e.g., Barrera-Bassols, Zinck, and Van Ranst 2006, 131–132). In Martinique and

St. Lucia, Feller and Blanchart (2010) show that farmers have their own theory of soil formation that contrasts with current mainstream scientific understandings, but such a theory seems to have developed by merging with earlier scientific theories. The view of soils as mainly an instrument for maximizing yield or as natural capital is instead one that emerges out of a specific, capitalist cultural complex that is predominantly of western European historical origin. Nevertheless, different kinds of knowledge about soils are mutually intelligible because biophysical processes are not reducible to people's shared notions, values, and beliefs, and because often what is regarded as local or scientific is an outcome of historical interactions among diverse social systems. In this sense, science is not comparable or analogous to a worldview or culture.

Ethnopedologists and others studying soil knowledge systems and the history of soil science should be mindful of this, instead of assuming a homogeneous scientific or technical perspective devoid of cultural specificity and then contrasting this presumed culture-free science with various local knowledge systems that stand in for different worldviews. Even within similar capitalist societies, there are multiple scientific or technical perspectives, sometimes at odds with each other, revealing the cultural framework out of which they emerge.

For instance, in a 2012 issue of the *Soil Science Society of America Journal*, three articles appeared of strikingly different persuasions. Drohan and Brittingham (2012) treat soils as avenues to facilitate shale-methane extraction using hydraulic fracturing techniques in Pennsylvania (USA). In a region where such mining is highly contentious, focusing on the manageability of the extraction process means supporting petrochemical industries. In contrast, Williams, Buck, and Beyene (2012) see soils in terms of their ecological benefits (water conservation and nutrient retention) by way of biological soil crusts in deserts (the Muddy Mountains Wilderness Area, Nevada, USA). Yet another article (Capra et al. 2012) shows how chemical industries in Sardegna have so altered the developmental trajectory of dry forest soils, through digging, movement, and re-deposition, as to turn them into thin dry soils with forest soil attributes. These works reflect a range of perspectives on soils that are steeped in social processes. While the first and second represent bourgeois struggles over environments relative to resource exploitation and conservation, the third implicitly throws a wrench in the nature–society dichotomy typical of capitalist societies (and the soil scientists who unwittingly reproduce the ideology) but without venturing into social causes.

In fact, social causes (e.g., local chemical industries' profit imperatives and political clout) are whitewashed through vague allusions to "industrial activities."

Even when soil scientists recognize the legitimacy of other forms of soil knowledge, they are unable to escape a bourgeois and/or settler colonial ideology. To illustrate, Gobat, Aragno, and Matthey (2004, 3) acknowledge that the "scientific approach is but one of many, all equally respectable and necessary to understand as soon as we leave the academic confines of research for its application." This soil science incarnation of liberal democratic rhetoric of equal rights, where ultimately might makes right, effaces actual scientific practice, such as consolidating, by elision, colonial institutions' annihilation of Indigenous Peoples' soil classification systems. In Australia, Fitzpatrick et al. (2003, 79–80) trace the first soil classification to the 1930s, thanks to the work of a white man named J. A. Prescott, who also brought some Russian soil scientific influence into the work. Later versions incorporated various aspects of American soil categorization schemes. In no occasion is there any question regarding the reasons for the absence of any influence by Indigenous soils knowledge or why the prospect has not been at all considered. The South African system seems also to have developed since the 1890s as if African societies and their soil knowledge systems never existed. Only the influence of the US soil taxonomy is recognized (Laker 2003). Similarly, any analysis or discussion of the knowledge systems of Indigenous Peoples or their possible contributions is completely absent in the Brazilian national soil classification system (Palmieri et al. 2003). In New Zealand, there seems to be little sign that soil scientists ever considered, for instance, Maori knowledge systems in devising soil categories, which was not systematically undertaken until the 1960s (Hewitt, A. E. 2003).

In the United States and Canada, erasing or marginalizing Native Americans is standard fare. In a recent publication on soil and water conservation in the United States, Tanaka et al. (2010) begin their description of the history of summer fallow cultivation in the Northern Great Plains with settlers' experiences. Native Americans simply do not exist, not even after the European invasions. Elsewhere in the same volume, this invasion is called "settlement." Apparently, the continent was unsettled until Europeans came. This is a pervasive wording that is a typical apologist maneuver in North America for a history of conquest and genocide. Soil scientists and agronomists reproduce such insidious terms probably without much thought behind it. Here is the fuller rendition:

> Before Euro-American settlement, the Great Plains were largely covered with grasses . . . During this prehistorical period, as later, the high evaporative demand and uncertain rainfall surely encouraged the first irrigation in the southern Great Plains, which occurred as diversions of surface waters in Kansas . . . and in the Oklahoma and Texas Panhandles.
>
> (Stewart, Baumhardt, and Evett 2012, 105)

To such authors, there are no Native American histories; it is all "pre-history" until Europeans arrive. Adding insult to injury, to these scientists the peoples who inhabited and still inhabit that region do not even have names (only "Hispanic farmers" are acknowledged). This settler colonizer discourse is shared by, if not derived from, the social sciences generally. It is part of a widespread and persisting settler colonial ideology (Abrol and Nambiar 1997; Leach and Mearns 1996; Seth 2009). In this, I take issue with leftists who deem colonial science a thing of the past or who view the present as a postcolonial situation (e.g., MacLeod 2001; Prakash 1999; Tilley 2011).

The above-described scientific investigations and statements evince the cultural context wherein they are carried out with respect to the expressed concerns and focus, the scope of the studies, and the often implicit ideological commitments, among other things. Soil science, as any other endeavor aiming to produce knowledge, cannot be regarded as independent of the social context in which it develops. Yet this is precisely how scientific or technical knowledge continues to be understood. Notwithstanding this troubling epistemological grounding, ethnopedology studies in particular demonstrate that what enables overlap in soil knowledge systems is the commonality of the nonhuman phenomena with which different societies relate and demonstrating this is in itself no small feat.

The issue, as exemplified by settler colonial perspectives on soil knowledge, is not so much about knowledge itself, as it is about the power relations that not only create but also privilege a knowledge system while suppressing and at the same time borrowing from others (Merchant 1980; Needham 1954; Van Sertima 1988). This is also where ethnopedological work could be a potent antidote, if it incorporated analyses of power relations as central. As Foucault (1971), among others, understood, knowledge is intertwined with power relations. However, in the case of knowledge of soils and nonhuman worlds broadly, there is a fundamental error in seeing knowledge as solely originating from social processes. That Foucault had virtually nothing to say about the environment is in this case no coincidence. It is patently not just humans who construct soils or environments (or even human bodies). Soils do not solely come about discursively and the processes that comprise what we may call soils do exist independently of our thoughts or "governmentality" about them. While insightful for studying environmental politics and people's understandings of environments (Luke 1999), a constructionist view is too rigid and restrictive. The distinction between science and local knowledge should anyway be regarded with much suspicion, if not rejected outright as a false dichotomy (or as a dichotomy that serves certain political ends). I concentrate in this volume on mainstream formal scientific perspectives on soils not because of their greater merits on the subject, but because they furnish criteria for global comparisons (necessary to analyze the environmental outcomes of an inherently globally expansionistic capitalist mode of production) and because such perspectives have become prevalent worldwide, informing, among others, institutional politics, environmental activism, and leftist approaches. In other words, my analytical emphasis does not preclude a critical appraisal of science and knowledge production outside formal institutions.

When Is Something a Soil?

Formal scientific definitions for soils vary, but they usually acknowledge that soils are made of broken-down materials from rocks and organisms. Some emphasize the definitive presence of organisms (e.g., Gerrard 2000, 1). Others do not appreciate organisms to the same extent, if at all (e.g., Juo and Franzluebbers 2003, 17). As reports from the Mars Viking and Sojourner space expeditions insist that soils exist on Mars (Certini and Scalenghe 2006, 208–210), some are devising ways to include other planets and reserving terms like "biomantle"[2] for planet Earth (Banin 2005, 889; Johnson, Domier, and Johnson 2005; Paton, Humphreys, and Mitchell 1995, 161). But prudence is strongly advisable here. If organisms and organic matter (OM) are optional, there is little reason to differentiate soils from, say, lifeless sand dunes in the Atacama Desert (Navarro-González et al. 2003). At this point, the term "soil" does not really convey much information beyond referring to a bunch of loose particles of various sizes, otherwise known as sediment (unconsolidated deposited materials). In this light, it would seem more sensible to opt for a more exclusionary ecological meaning (Gobat, Aragno, and Matthey 2004, 11; Young and Ritz 2005, 32) and posit that the creation of soils requires organisms (USDA 2006, 1; Yaalon 2000). In contrast to sediment, then, soils are composed of organisms, water, air, and bound weathered mineral and organic material. According to the more ecologically minded, it is decisively bound at the molecular scale, as a clay–humus complex[3] (Gobat, Aragno, and Matthey 2004, 65). This last aspect could be used to ascertain the distinction from sediments, but this may not be workable in the case of subaqueous soils, for example (Demas and Rabenhorst 1999).

The range of sometimes contrasting definitions reflects the difficulty of identifying soils. As admitted by the Soil Survey Staff of the United States Department of Agriculture (USDA), “In some places the separation between soil and nonsoil is so gradual that clear distinctions cannot be made” (Soil Survey Staff 2006, 1). Besides omitting the existence of debate on this matter, the USDA staff might be underestimating the frequency of such murkiness. Figure 2.1a–c shows three cases to illustrate the point. Picture (a) is from Oakland’s Estuary Park (California, USA), displaying pickleweed (*Salicornia* spp.) at low tide and growing at the brackish water’s edge. During high tide, such succulent salt-tolerant plants are usually submerged in part or entirely. Picture (b) shows a pit dug on cultivated land, exposing a soil profile in Rádfalva (Baranya County, Hungary). Picture (c) shows several deciduous trees living on conglomerate sandstone on the lower-lying eastern portion of the Shawangunk Ridge (New York State, USA).

Figure 2.1a A selection of soils in different environments

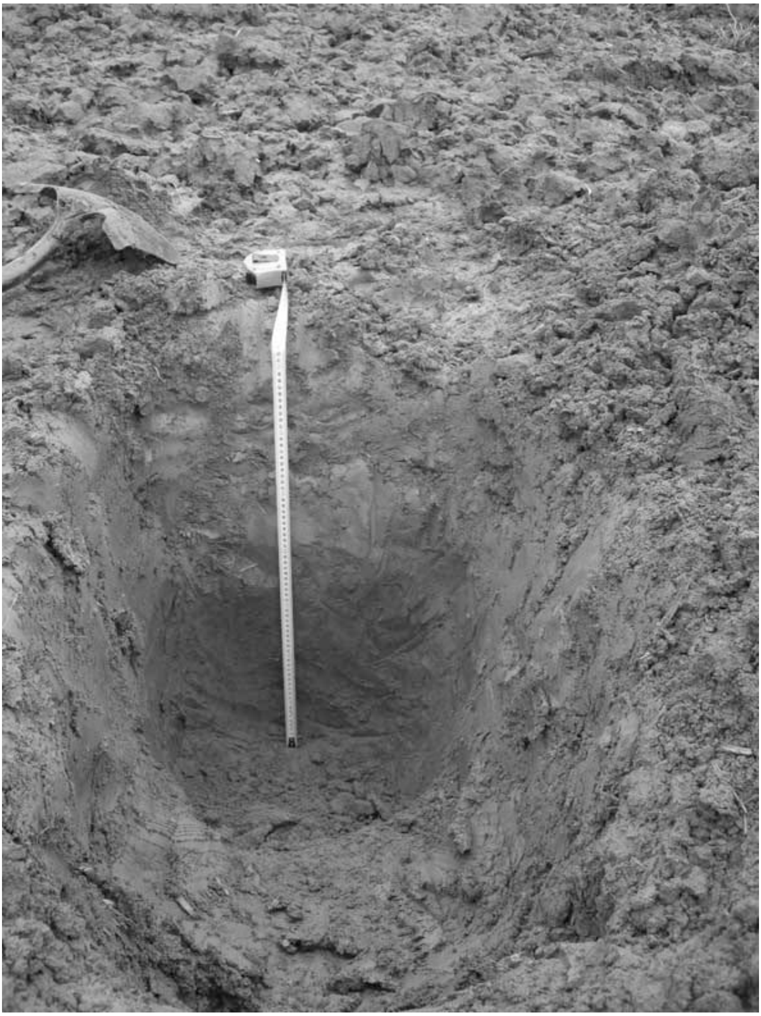

Figure 2.1b (Continued)

In one way or another, all of the illustrations can be considered soils, depending on interpretation. The first example might seem surprising, but since at least the 1970s, there has been official recognition of submerged (hydric or wetland) soils, mainly in terrestrial and coastal wetlands (Kirk 2004; Mausbach and Barker 2001, 20). Soils have even been argued to develop under shallow seawater (less than 2.5 m at low tide), in estuaries and coastal marine environments. This is because

Figure 2.1c (Continued)

those soils show distinct layers forming through variants of the basic soil-forming processes described on land. Bottom-dwelling organisms like seagrass not only anchor themselves on underwater sediments but also actively shape the characteristics of the sediment on which they settle. By so doing, they lead to the formation of layers with heterogeneous attributes, like carbonate enrichment, the formation of humus (highly decomposed organic material), and the movement and modification of elements like iron and sulfur (Bradley and Stolt 2003; Demas and Rabenhorst 2001).[4] Underwater soils are not, incidentally, a new category. Some have thought of them as soils as far back as the 1800s (Demas and Rabenhorst 1999).

The second case probably qualifies as soils in most people's estimation because of its location and the relatively loose underlying material. This is the usual way soils are understood, as land-based resources. Yet the barely perceptible thin soil associated with plants growing on a rocky outcrop—the third example—does not appear to fit the conventional pattern. It is far from obvious where soil begins and ends. This third illustration of trees growing directly on rock suggests that using rooting depth as a gauge, as often done, does not necessarily yield any more clarity about soils and is actually contradicted by microorganisms thriving where no roots can reach (Buscot 2005, 3).

This matter of defining and identifying soils may seem pedantic, but there can be a lot at stake. Consider the issue of soil erosion and biodiversity. The recognition of subaqueous soils implies a need to revise soil erosion estimates, as eroded material can benefit subaqueous soils' development (Demas and Rabenhorst 2001), and to include marine species as part of soil biodiversity accounts. A lack of differentiation between soil and sediment can lead to inflating erosion figures, if one, for example, counts erosion of beach or arid land sediment. Martian soils have repercussions for soil degradation accounts. None of this means that the great variety of features under the surface we walk on (or dive into) defies definition, but there needs to be much greater acknowledgment of such problems by experts compared to the peremptory statements they typically make.

Soil Formation (Pedogenesis): Processes and Factors

Criteria to distinguish soils rest on theories of soil formation, whether so admitted or not. Most see the role of organisms as foundational in altering sediment to produce soils. Hence, those proposing the existence of soils on other planets directly contradict this generally accepted view and, as far as I know, cannot address the problem of distinguishing soils from sediments. Generally, there is consensus that the current characteristics of soils form out of the additions, losses, and internal movements and transformations of materials. Additions are exemplified by OM accumulation as fallen leaves are biodegraded and made eventually into humus. Removals can include such things as rainfall-induced erosion or leaching out of nitrates from a soil and into groundwater. Translocations involve such processes as water percolating from one horizon (layer) to another or rocks being heaved upward by ice forming and expanding in the lower parts of a soil. Finally, transformations can be illustrated by regular weathering of minerals or the breakdown in place of organic compounds (Buol et al. 2003; Gerrard 2000; Schaetzl and Anderson 2005). These processes that happen within soils are crucial to the cycling of major nutrients and water in ecosystems. So, if soils are degraded, the cycles are hampered and the whole ecosystem is affected. Processes of soil formation are intimately linked to the functioning of most land and coastal ecosystems (Buscot 2005; Wall, Fitter, and Paul 2005).

These four soil-forming processes occur through the interactions of several overarching factors. This way of understanding soil formation is often called the functional-factorial model. Most agree on the main factors being climate, organisms, topography, and parent material (original materials out of which soils form).[5] Climate affects soil formation through, for example, precipitation and temperature contributing to the weathering (physical or chemical breakdown) of rock minerals. Relatively high precipitation can alter the pH (often lowering it over time) and accelerate weathering and movement of material down the soil. Organisms can leave long-lasting, if not permanent, imprints on soil properties. For instance, some people in some societies add marl or lime to raise soil pH and fertility. Trees, with their usually longer rooting depth, tend to provide more soil stability, but less OM than grasses, which contribute greater topsoil humus with their high rootlet turnover rate. Termites and earthworms can mix and relocate large quantities of soil, while microorganisms, such as bacteria, are crucial to nutrient cycling (e.g., populations of the bacterium genus *Nitrobacter* facilitate the oxidation of nitrite to nitrate, a form of nitrogen used by plants). Beavers (*Castor canadensis*), by constructing dams, foraging, and digging, have a major influence in the formation of wetland soils by modifying stream velocity and capacity (affecting sedimentation and erosion rates and distribution) and mixing and inundating soils, among other impacts (Johnston 2001). Topography affects soil formation through elevation, aspect (the slope's cardinal orientation), and slope geometry. For example, slope geometry, especially the length of a slope, affects erosion rates. Soil chemical and mineralogical characteristics sometimes reflect the parent material on which it developed. For instance, some soils are acidic as a result of underlying or added material derived from felsic igneous and metamorphic rock, such as granite and gneiss. These factors interact over time so that time can be considered an additional factor. Some justifiably add extreme events or catastrophes, such as hurricanes and earthquakes, or some forms of human activity because of the magnitude of impact (e.g., large volumes of earth movement), sometimes wiping soils out altogether (Certini and Scalenghe 2006, 205–208; Rozanov, Targulian, and Orlov 1990; Schaetzl and Anderson 2005, 293). Because soils are the outcome of the interaction of several factors acting over differing durations and at differing rates, there is great soil diversity.

It can take hundreds to thousands of years to form or destroy a soil, and sometimes it can take minutes to months, depending on how these factors interact and on the occurrence, magnitude, and/or frequency of extreme events (including by way of human actions). The potential for regressive effects contrasts with the more popular notions of soil formation as a linear, progressive tendency toward the attainment of an ultimate steady-state soil (not coincidentally reminiscent of climax community theory in ecology or the wider belief in a static "balance of nature" only disrupted by humans).[6] Some argue that parent material or even the subsoil above parent material has often little or nothing to do with what happens on the surface (Brookfield 2001, 89–90; Paton, Humphreys, and Mitchell 1995).[7] Topsoil has also been shown to develop much more rapidly than the millennia required for mineral weathering (breakdown) and resistant OM decomposition. Sometimes it develops more than 10 cm over a few decades and then the process slows down considerably (e.g., Howard and Olszewska 2011; Phillips, Turkington, and Marion 2008; Stockman et al. 2010). In the end, there is no predetermined type of soil for a given set of conditions simply because the state of soil-forming factors changes and the developments within soils themselves (e.g., downward clay movement after carbonates are dissolved) can lead to the irrevocable crossing of thresholds (Gerrard 2000; Phillips 2001; Schaetzl and Anderson 2005, 295–317).

The Status of Human Impact Relative to Soil Formation

In the various models of pedogenesis, human intervention has rarely featured as intrinsic to the story. This is reflected in the continuing ambiguities in soil classification nomenclature aiming to include human-altered soils (Bryant and Galbraith 2003, 62; Dudal 2004; Lehman 2006). Yet people shape the course of soil development in many ways, both constructively and destructively (Brookfield 2001, 96–99; Rozanov, Targulian, and Orlov 1990). Certain soil types or characteristics would not even exist without the influence of specifically human intervention (e.g., Eidt 1977; Sandor and Eash 1995; Yaalon 2000). The form of human impact varies considerably over time and place. There are general trends that have been picked up by soil scientists even with the coarsest of analyses and that point to a general chronological sequence in terms of progressively greater intensification of human impact.

Prior to capitalist social relations, the norm, excepting some large centralized authoritarian societies, seems to have been more constructive in the relationship between people and soils. In many places, over the span of centuries to thousands of years, the development trajectory of entire soils has been ineluctably altered because of terracing, which can reduce erosion, or contributing organic materials, such as in the case of *terra preta* or *plaggen* soils (*Anthrosols*, in the FAO classification system), whose present high fertility and overall characteristics is closely related to the impacts of past, non-capitalist societies (Beach et al. 2002; Davidson et al. 2006; Kaufman and James 1991; McFadgen 1980; Sandor, Gersper, and Hawley 1986; Van Smeerdijk, Spek, and Kooistra 1995; Xiubin et al. 2002). Impact has also been occasionally destructive or transformative through, for instance, deforestation-related accelerated erosion and irrigation-induced salt build-up.

Recently human influence has intensified in unprecedented and mostly deleterious ways (but see Chapter 4). Soils are enriched through a large variety of sources with synthetically produced nutrients, heavy metals, and/or organic pollutants. Mining for ores, fossil fuels, or even topsoil has resulted in truncation or complete disappearance of soils. There can be compaction due to heavy vehicle traffic and the constant modification to water and air flow with the introduction and maintenance of subsoil tubes, pipes, and wires. Soils can be covered up with asphalt, cement, or other less permeable materials, and this effectively buries soils. Industrially produced acid rain and dust can shape the chemical characteristics of soils, as does the addition of lime or sulfur compounds to change soil pH. Dumping of loose earth on top of a soil alters the make-up of horizons. Deep plowing leads to greater exposure of OM to oxygen and enhances its degradation. The alteration of soil organism habitats (e.g., reduction of OM) can lead to higher rates of soil erosion, as in the case of some endogeic earthworms (Blanchart et al. 2004). Soils have developed out of construction debris, landfills, and assorted accumulated rubbish, among other sources, such that parent material may be human derived. Such impacts are also altering soils that developed their characteristics as a result of human impact, such as terracing and OM input. Terra preta soils are being exposed through plowing where plantations have been established, increasing OM losses. In some regions, hardship induced by capitalist policies (e.g., favoring factory employment) has led to depopulation, terrace abandonment (and collapse), and erosion (e.g., Yaalon 1997). These days, soils are even manufactured synthetically as turf or topsoil for market sale, something that is also rarely recognized by soil specialists and that after centuries would likely be difficult to discern from human-impacted soils developed in place.

A study of why it has taken so long for soil scientists to attend to this issue could make for a separate treatise, but one could start with the thesis that subservience to market-oriented farming, associated with ideologies of human nature (which persist in different garb), stymied the development of analytical tools in soil science to study the effects of human impact on pedogenesis. Concerns over human impact have long existed, but were quite selective (largely confined to farming issues), and from the 1920s, by way of soil conservation, often served colonial dictatorships or government disciplining of small-holding farmers (Blaikie 1985). Not much attention was given to human impact outside farming until the 1960s (e.g., Simonson 1973; Zemlyanitskiy 1963) and only within the past two decades have there been concerted efforts to revise how soils are classified (e.g., ISRIC 2002), with various agencies set up for the purpose, such as the International Committee on Anthropogenic Soils.[8] It is not any advancement through new discoveries that enable soil science finally to encompass the study of humans' role in soil formation. Instead, it is a change in many soil scientists' perspective related to wider changes in society, which affect the ways in which soil formation is conceived, as well as how soils are defined and categorized. This is occasionally revealed by soil scientists themselves, especially in more introspective works about their role in the world. This is exemplified by acknowledging that soil science was tied from the start to agriculture institutions, to the detriment of studying soils as part of ecosystems or of developing soil science as part of a wider environmental science (cf. Keeney 2000; Menzel 1991; Singer and Warkentin 1996).

Nevertheless, there has been debate on people's roles in the making of soils, especially over the past couple of decades, focused on whether humans should be considered as part of the organisms factor (e.g., Amundson and Jenny 1991; Jenny 1941) or as an entirely separate factor (e.g., Effland and Pouyat 1997; Hillel 2008, 20). Those who prefer to retain a single factor for organisms still confer people special or exceptional status compared to other organisms (e.g., abstract reasoning, goal-directed behavior), so it is difficult to tell these arguments apart. Dudal (2004, 2), for instance, insists on humans as a separate factor but on the basis of the same reasons as Amundson and Jenny (1991, 101).[9] Others argue that human impact cannot be treated on an equal basis with other factors because of "the relatively brief time-span over which humans have altered soil" and because, "when the human influence is strong, the other state factors are usually forced to change" (Schaetzl and Anderson 2006, 317).

This issue seems much more a form of pedantry. The view that human influence has been too brief compared to that of other factors is difficult to reconcile with the thousands of years of pedogenic effects of various forms of impact (e.g., Yaalon 1997), including agriculture, which Schaetzl and Anderson themselves mention (2006, 318). In fact, ancient human influences on soil formation have set the stage for more recent human-induced changes that are so far only decades in duration, as in the use of *plaggen* soils in The Netherlands for industrialized farming. It seems the matter of brevity is entirely beside the point. Such reasoning also underestimates, if not ignores, other long-term and ancient anthropogenic effects, such as with the use of fire, the practice of herding, building of housing structures, and the making of pottery (which entails clay mining from soils and has been confirmed for some ancient gathering–hunting societies; Kaner 2013). Human contribution to soil-making should instead be considered as ancient as the human species, in one degree or another, since land-based organisms always have some effect on the formation and development of soils.[10] Finally, instances of greater anthropogenic intensity may have effects similar to extreme events like volcanic eruptions, but seismic events or climate change also have effects on even the most soil-impacting societies. There is, therefore, little justification for excluding humans from being part of the organisms factor or for giving humans an exceptional role in the formation or destruction of soils.

Limits of Soil Science in Addressing Human Impact

Ultimately, the issue is not about adding another factor or not, but about the relative degree and form of human impact, which varies tremendously over time and place (Rozanov, Targulian, and Orlov 1990, 204–205). To appreciate that diversity of impact, at a minimum one must consider differences within and between societies, rather than refer to a generic humanity. The frequent presumption that urban soils can be lumped together and described through the same approach belies the inability of soil scientists to consider the heterogeneity of cities, many of which are not industrialized or have little to no histories of large-scale manufacturing. This is another illustration of the repercussions of failing to study social processes, which largely determine urban characteristics and hence soil formation in those places. One should be equally attentive to other organisms' variable impacts within species relative to context, but this is seldom done and soil ecosystems remain understudied (Wall, Fitter, and Paul 2005). Some studies suggest a negligible impact on soil dynamics, but the effects examined are typically limited to the relationships between organisms. For example, root composition diversity within cabbage has been found to lead to greater or lesser numbers of nematodes without altering the soil food web, but the analysis is confined to interspecific relations (Kabouw et al. 2010). In contrast, West et al.

(2001) report that different populations from the same earthworm species (*Lumbricus rubellus*) excreted different amounts of strontium, which over time could affect that element's distribution in soil (see also Sizmur et al. 2011).

In soil science, this sort of rare, detailed intraspecific analysis does not really exist with respect to human impact. Just as in the current distinctions made in the FAO system between *Anthrosol* (namely agricultural) and *Technosol* (namely urban), soil scientists tend to lump different societies together on account of similarities in outcomes of land use. As a result, one gets the impression that they have trouble distinguishing between such land uses as intercropping and ley-fallow systems or between large metropolitan urban centers with very little (e.g., Rome, Italy) and intense (e.g., Philadelphia, USA) manufacturing histories (McDonnel and Pickett 1990; Sandor, Burras, and Thompson 2005).

Soil scientists rarely venture into analyzing the social aspects of soil formation, but when they do, the results leave much to be desired. For example, Amundson and Jenny (1991) formulate a model that includes genetic and cultural variations as independent factors[11] and human phenotypic and cultural inheritance as dependent on genetics, culture, climate, organisms, topography, parent material, time, and other soil-forming factors. To simplify their convoluted approach, the authors claim that people use soils in different ways in part because of environmental factors, genetic predispositions, and cultural inheritance. Besides the tenuous evidence,[12] the notions that they propound are misleading and politically reactionary. Imagine attributing soil degradation through warfare, incinerators, plantations, and roadways to the combined effects of human genetic predisposition, cultural traditions, and environmental forces beyond human control. These kinds of arguments resurface in some respects in the latest attempt to address human influences by way of the concept of Anthropocene, which has recently stimulated some rethinking about humans' role in pedogenesis. For instance, Stiles (2012) makes the startling claim that

> [i]t is well-known that different cultures have evolved in response to prevailing environmental conditions, which are also forcing factors in soil formation. Thus, it is easy to see that equivalent cultures developed on similar soil types despite wide geographic separation . . . The uniqueness of cultures drawn from the land is less notable in the Anthropocene, as most people are now far-removed from the close relationship with the natural surroundings that shaped cultural knowledge.

Notwithstanding the bold (but possibly more interesting) notion that the Anthropocene started only some decades ago, it would be interesting to know what the author thinks are the conditions to which Anthropocene societies now respond (if they presumably also evolve). Apparently, such environmental changes as rising frequencies of high-magnitude hurricanes or diminished UV-ray protection from ozone layer disruptions have no bearing whatsoever on Anthropocene societies. Then again, according to this view, there is no difference between, say, Lakota and Ukrainian societies, since both evolved out of Chernozems. What is more, modern Anthropocene gatherer-hunter, pastoralist, and agrarian systems are indistinguishable from each other and from industrialized versions. And the evolution of polities like the Roman and the Inka Empires is the result of such a vast number of soil types as to make the argument truly unassailable.

It is unfortunate that soil scientists' attempts to include and analyze social processes tend to skip the bulk of empirical evidence, disregarding social science research and theory. For instance, in the above-cited work by Amundson and Jenny, the authors could have addressed how changes in pedogenic factors affect soil formation through both environmental processes, such as increased aridity (regional climate change), and social processes, such as the invasion of capitalist colonizer societies in the Great Plains (changes in organism impacts). Soil scientists have no difficulty in spotting the first, but the latter social processes remain beyond their purview. The more serious work of studying actually existing social relations and their effects on soils has instead been done by social scientists, but with a commensurate lack of attentiveness to soil specificity and dynamics (see Chapter 6).

Thus, soil scientists' quandary regarding the status of human contributions to soil formation should be seen as an artifact of inadequate social analysis and/or lack of interest in the copious work of social scientists. Nevertheless, the problem of humans' status relative to pedogenesis could still be seen as technical in character. There would just need to be clarification about criteria regarding what counts as minor or major human impact relative to other soil-forming factors and systematizing impact according to type and degree. This is being addressed to some extent (e.g., Bryant and Galbraith 2003; Weinberg 2012). But in the end there remains a fundamental flaw resulting from soil scientists' omission of relations of power and social context. Soil scientists presume societies to be isolated from each other and all people in them as virtually the same, with the same impacts on soils. Perhaps such scientists might start understanding the importance of social specificity if they were accused of having the same impact on soils as the head of a nearby agribusiness or industrial plant.

Categories like *Anthrosol* (long-term farming influence with horizon development) or *Technosol* (short-term, recent, industrial influence, with little or no horizon development), and other such attempts to integrate human impact in soil formation explanations, fall short on accuracy relative to actually existing varieties of social systems[13] and support a view that humans are separate from the rest of nature (Bullock and Gregory 1991; Capra et al. 2013; Effland and Pouyat 1997; Meuser 2010; IUSS Working Group WRB 2007; USDA 2006), rather than viewing human impact as transforming and being transformed by wider ecological as well as soil processes. Making the uniqueness of human impact into a basis for classifying a soil implies negligible or no human impact for other soils, an untenable proposition by at least some soil scientists' reckoning (Certini and Scalenghe 2006; Schaetzl and Anderson 2006, 318–320). Even in situations of overwhelming human-derived effects, like heavy metal pollution, other organisms, such as anecic earthworms (*Lumbricus terrestris*), can play a determinant role in the actual mobility of heavy metals within soils (Ruiz, Alonso-Azcárate, and Rodríguez 2011; Sizmur et al. 2011). Reducing soil development to what a single organism does is therefore misleading. Worse, it creates an implicit dichotomy whereby some societies are accorded soil-forming factor status, while other societies, by default, become part of "natural" soils. By clinging to the above-described assumptions and omissions, soil scientists reinforce the internally inconsistent capitalist colonizer ideology of nature, whereby people are thought of as outside or part of nature according to political convenience (Smith 1990).

It is, in short, gratuitous to divide soils into anthropogenic and "natural" categories. Instead, nomenclature could be developed that refers to actual human impact and, possibly, specifies the types of social relations behind it. To clarify, there can be no direct relationship between social system and soil formation, because human impact is but one soil-forming factor, different forms of human impact can be superimposed one on the other over time, and different social systems can have similar impacts on soils. In any case, the inclusion of social relations would go beyond the scope of soil formation explanations and soil classification, but such an approach, which would need much study even to consider the multiple-scaled spatio-temporal processes and to configure appropriate scale-specific precision for social categories used, could provide the more politically aware and socially critical appraisal of soil formation processes necessary to establish context-sensitive ways of promoting ecologically attuned egalitarianism. Identifying social relations tied to human impact would, regardless, force soil scientists to stop hiding behind a façade of objectivity and neutrality when it comes to human impact.

Such a more socially informed classification system and, implicitly, pedogenic model, need not involve an overhaul of existing taxa. For instance, the term *Anthrosol*, in the FAO system, could be replaced with an existing applicable term, such as *Regosol* (soil in unconsolidated material with little horizon development), a default category for soils difficult to classify. The term already presumes specific ranges of parent material and climate influence, but more ranges could be included for multiple forms of human impact over time (e.g., organic additions over centuries, followed by agrochemical inputs over decades). Sub-categories could be devised to specify whether it was affected by a single type of human influence (e.g., predominant forms of organic materials added, type of tillage). This requires much more careful and in-depth study (and expense) that relies on multiple forms of knowledge (not just of the formal scientific variety), but it would provide much more information toward assessing the degree of human involvement in soil formation without reducing soils to human impact or differentiating human impact according to "artificial" or "natural." This would give an eco-social twist to the basic notion that "without having a firmly based model of soil formation there can be no meaningful classification" (Paton, Humphreys, and Mitchell 1995, 9).

Classifying Soils

Like defining soil, classification systems partially reflect a society in which they are forged. The assessment of and even categories for soils are linked to the sort of society and environments in which soil scientists have lived and grown up. One sign of this is the existence of numerous scientific classification systems that, with the exception of the FAO system, are typically national in scope, as if soils obeyed political boundaries or government administrative units. These national systems often show gaps in the capacity to account for soil types that do not exist within national boundaries. In this way, scientific soil classification demonstrates both social and environmental specificity or limits (Gerrard 2000; Yaalon and Berkowicz 1997).[14] The political process here is the reproduction of national state ideology through the implicit concept of nationally bounded soils.

It is therefore emphatically not a central problem of soil classification that there is “No single classification [that] can equally serve all who seek to study and obtain sustenance from soil” (Buol 2003, 3). Buol (2003, 7–9) distinguishes between analytical, political, economic, managerial, and ecological needs that guide the making of soil categories. As useful as it is to be aware of a diversity of interests, it is of greater significance to investigate how these different interests arise from within a social system. Without doing this, we miss the underlying reasons that motivate soils being classified in particular ways and so we cannot explain why or how classification systems change and/or end up trumping others. Diverse soil classification systems, rather than indicate various audiences, reflect, often subtly, social contradictions and tensions. There can be a sharp conflict between understanding how a soil should relate to the rest of its ecosystem and the uses to which humans want to subject a soil. This distinction translates into our knowledge of soils in terms of studying how they function, with or without human intervention, and assuming a particular hierarchy for the best uses of a soil. In fact, an ecosystem understanding of soils already implies a set of priorities regarding the most appropriate uses of soils. There is no politically neutral classification system.[15]

Politics in Classifying

One illustration is the shaping of soil science concepts and applications through changing social relations of power in Hungary (Engel-Di Mauro 2006). Over the course of various political-economic shifts, particular assumptions emerged in soil science regarding the subject/object of analysis (e.g., the identity of the farmer), the definition of legitimate evidence (e.g., what soils are to be investigated), and methodology. Thus, although mainly peasant women used wetland soils to gather foods for subsistence, such soils were not recognized as such until they could be used toward lucrative ends, dominated by male farmers. With the state-socialist regime came an explicit reduction of soils to capital. Subsistence farmland, largely used by women and elderly men, was then systematically excluded from soil survey, classification, and monitoring.

In the US context, Buol illustrates the political interests involved in wetland soils policy, from advocating drainage in the 1950s to conservation by the 1990s. But does not this historical change in policy and in economic valuation affect the analytical needs of soil scientists in the study of wetland soils? Does it not affect how soils in wetlands are managed? Does it not affect how soil scientists have come to view soils as part of ecological interactions affected by humans? It was not until after the passage of the Clean Water Act in 1972 that an inventory of soils associated with wetlands was carried out as part of the National Wetlands Inventory of the US Fish and Wildlife Service. The result was the introduction and elaboration of the concept of "hydric soils" (Mausbach and Barker 2001). This analytical category did not exist until after a political change in society brought into focus a concern for wetlands and the environment generally. Moreover, widespread wetland drainage before the 1970s destroyed many of what came to be known as hydric soils.[16] Comprehension of wetland soils has not been helped by the reduction in their extent. Clearly, political change affects and may even direct soil scientists' analyses. Wetland soil classification might seem apolitical or detached from society until one excavates the priorities ensconced within definitions, descriptions, classifications, and evaluations.

These case studies, besides showing how the foundations of soil science are enmeshed in politics, indicate that scientific experts do not necessarily wilfully formulate concepts and terms to dissemble any ulterior motives. The problem is that prevalent views are taken for granted. Without taking into account that the biophysical also entails a social understanding, there will continue to be a reinforcement of socially predominant ideologies, a passively political act. The problems of identifying soils, defining them, classifying them, and explaining their formation and development are not resolved by clarity, systematicity, and consistency alone, although they help. They must also involve critical awareness that definitions, categories, models, and explanations are not neutral. Knowing what a definition excludes can be as important as expressing its content. Naming something a soil reflects not only the characteristics of a variable mineral-organic process, but also socially specific perspectives of ways of sensing the world. Similarly, the making of categories for soil classification is an undertaking often guided by prevailing assumptions, as when capitalist farming is tacitly taken as the standard.

The inescapably social aspect of ascribing meanings or definitions to soils does not imply the impossibility of a definition or categorization that is less socially assuming or exclusive. By contextualizing and critiquing scientific soil knowledge, there can be more inclusive ecological and social understandings that at least avoid reinforcing repressive ideologies. Issues such as when something is a soil are instead taken for granted by many and implicitly left to experts (usually soil scientists) to decide. But the experts themselves are inconsistent on what a soil is and they introduce sometimes politically reactionary elements in their definitions, taxonomies, and soil-formation models. These should all be reason enough for leftists to take an active role in the biophysical sciences, rather than just critiquing them from the outside or relying on expert knowledge.

CHAPTER 3

SOIL PROPERTIES AND THE POLITICAL ASPECTS OF SOIL QUALITY

As argued in Chapter 2, soil knowledge systems are context-specific, but they overlap because soils also exist independently of society. Associations of interacting organic and mineral materials, organisms, air, and water (i.e., soils) occur independently of how we explain them. Explananda are anyway not reducible to their explanantia. The biophysical sciences cross social contexts, even as they are socially constructed. Besides there being no single version of science, the biophysical sciences should not be conflated with Western European ideological predominance since they are the historical product of the workings of different interacting social systems and people–environment relations. In this work, mainstream scientific views about the environment, including soils, are used and placed under scrutiny because they form the basis for global comparisons and the backbone of soil knowledge generally, even among the most ardent critics of "Western" science, who do not jettison, for example, studies on soil erosion or climate change on account of the studies' social provenance (see also Blaikie 1999). With such understandings of science, soils can be defined as both land and, to a limited extent, subaqueous phenomena comprised of bound mineral and organic materials, together with living organisms, water, and air. They are weathered mineral and/or organic material organized in layers (horizons) and characterized by the binding of mineral and organic substances, possibly at molecular scale (the clay-humus complex). Soils form by the addition, loss, movement, and transformation of materials. Over time, soils are created with the pivotal involvement of organisms, including people, alongside other major influences, namely climate, topography, parent material, and relatively low frequency high-impacting phenomena (earthquakes, volcanic eruptions, meteorite bombardment, and the like). Interactions among and change within these factors produce soil diversity (Phillips 2001b).

What follows is an overview of major soil properties (biological, physical, and chemical) because they form the basis for evaluating the state of a soil (soil quality) and hence whether a soil is deemed to be degraded (a topic taken up in Chapter 4). The properties of a soil may develop without any influences from human activities, but soil evaluation is obviously done by people, who have ideas about how soils ought to be used, for what ends. These ideas come from interactions in society, not just from interactions with soils. Soil qualities are formulated and judged accordingly, regardless of whether those involved in such formulations and judgments are aware of this. In fact, a recurring problem is that they are at most superficially aware of the social aspect of their work. Soil degradation must therefore include a study of the social context out of which it is defined. Determining or even coming up with the concept of soil degradation points to a contrast with a stable or functioning soil. And it matters a great deal which people make such contrasts, their social position, and the conditions under which they work. As Blaikie and Brookfield (1987, 1) remind us, degradation entails ranking and this "implies social criteria which relate land to its actual or possible use." As shown below, the social criteria tend to be dissembled through the development of parameters focused on soil properties, which are used as a means to establish standards of evaluation. Even on their own terms, such standards, as some soil scientists point out, reflect the regionally specific environmental circumstances and are poorly applicable to other places. Assumptions about society, typically left unscathed, tend to deny the existence of relations of domination and take capitalism for granted. Leftist works on soil degradation have been rare and confined overwhelmingly to critique. Alternatives have so far been wanting, so a reconceptualization of soil quality toward an egalitarian, hence anti-capitalist alternative is proposed at the end of this chapter.

SOIL PROPERTIES

Out of the interactions over time between climate, organisms, parent material, topography, and high-magnitude events and through material additions, losses, transformations, and translocations, soils develop distinctive characteristics or properties and an overall appearance (morphology)—including a vertical succession of layers (horizons). Herein only a few of each type of characteristics is described and that are useful in assessing whether soils are degraded. Typically, these properties are divided according to whether they are primarily biological, physical, or chemical. It should be however kept in mind that all these properties are interrelated in one way or another. Their separation is for analytical purposes, to facilitate the interpretation of a large array of attributes.

Biological Properties

Biological properties refer to the species composition of soils and to the activities and interactions of soil-dwelling organisms. These can be quantified through biomass measurements, microscope-aided counts, respiration (total CO_2 evolved from microbial populations), assays of genetic material (nucleic acids) and enzymes, total organic carbon, biodiversity, and other forms of measurement (Thies 2006). Some soils, such as in arid and tundra environments, have fewer organisms, but in many parts of the world, soils teem with life. The level of biodiversity and soil-organism activity and functions are affected, sometimes only indirectly, by factors like (micro-) climate, topography (e.g., a soil at a valley bottom may be frequently waterlogged), and the effects of above-ground organisms (including us). Under a temperate forest, for instance, the number of organisms can climb to tens of millions per cubic meter, rivalling tropical rainforests and coral reefs (Giri et al. 2005). Their importance has been appreciated for some time. Charles Darwin (1881) even dedicated an entire volume to earthworms, but not until the last few decades have soil scientists started concentrating on soil biota (Wall, Fitter, and Paul 2005).

Soils are then underground ecosystems with specific features, such as a “labyrinthine pore network” (Young and Ritz 2005, 32) and high functional redundancy of species owing to an abundance of spaces out of predators’ reach (Bardgett, Yeates, and Anderson 2005). Organisms in soils vary in sizes and some, such as arthropods and rodents, do not live solely in soils and can be quite large. Soil-dwelling organisms consist of bacteria (eubacteria and arcaheobacteria), fungi, protozoa, slime molds, flora (e.g., algae), and fauna (e.g. nematodes, mites, and earthworms). In one way or another, they all contribute to producing and/or developing soils, imparting characteristics such as how well mineral particles are bound together or the degree of organic matter (OM) breakdown (Magdoff and van Es 2000, 13–20).

Broadly stated, soil organisms together, as part of a subterranean ecosystem, accomplish the following: (1) the breakdown of various organic and mineral materials (including compounds harmful to us), (2) the mineralization (conversion to minerals) and movement (cycling) of matter within and between soils and from soils to other environments (e.g., cycling and converting between different forms of nitrogen and carbon to and from the atmosphere, bodies of water, above-ground ecosystems), (3) the mixing of soil materials and the creation of spaces between solid soil particles (aeration), (4) the addition of organic acids and carbon dioxide to the soil, and (5) the cycling and storage of nutrients. These are crucial contributions soil organisms make that not only determine many soil characteristics, but also enable the functioning and influence the processes and characteristics of above-ground ecosystems (Bardgett 2005; Gobat, Aragno, and Matthey 2004). Soil ecosystems are deeply interwoven with soil physical and chemical properties, which provide the habitat, also created through dynamic and mutually constitutive interactions between organisms and the physical soil environment (e.g., Ouédraogo, Mando, and Brussaard 2006).

Physical Properties

Physical properties are composed of air, water, and solid particles, a portion of which is derived from organisms themselves as OM. Among the major soil physical traits are total depth, colors, texture, structure, consistency, density (known as bulk density), porosity, permeability, temperature and moisture ranges, and the soil particles' arrangements at the macro- and microscopic level (soil fabric and micromorphology), amounts of different kinds of oxide and oxy-hydroxide minerals (e.g., different compounds of iron and aluminum), concretions and cemented layers, amounts of carbonates, as well as the predominant kinds of minerals present or mineralogy (for an overview, see Ellis and Mellor 1995; Magdoff and van Es 2000; Schaetzl and Anderson 2005).

Total depth is taken to be from the soil surface to the rooting limit or to bedrock or sediment. This varies according to context, but it is also questionable whether rooting depth should be employed as a criterion, since many microorganisms can thrive beyond the rooting zone. Soil color is quite an important description to note, as it can immediately give an impression about, for instance, levels of organic material (darker hues) or of the presence of different kinds of iron compounds (reddish, brownish, yellowish hues). Texture refers to the relative amounts of mostly silicate mineral particles of different average diameter,[1] called clay, silt, sand.[2] The clay or colloidal fraction ($<2\mu$m) is the one that most reacts with other substances, binding not just with OM, but also attracting ionic forms of compounds and atoms, including plant nutrients (e.g., potassium) and trace elements (e.g., arsenic). Clays are in this way like temporary nutrient storage areas. They also furnish elements, including nutrients, as they are broken down and/or transformed through many types of mechanical and chemical reactions. Because of their variable internal structure, some clay minerals (e.g., montmorillonite) are much more reactive than others (e.g., kaolinite), though not as much as OM, so that there can be considerable differences in soil fertility connected to clay mineralogy (Gerrard 2000, 22–29).

Structure is the shape and direction of soil particle clumps (aggregates), which give stability to soils. These aggregates are made possible largely by a combination of clay particles mutually attracted by ions of more than one charge (e.g., Ca^{2+}) and fixed through organic substances and even living microbes (for aggregates smaller than 250 μm) and of OM serving as glue (for larger aggregates). Larger aggregates require a constant replenishment of OM, which is broken down by microorganisms (Chotte 2005). The degradation of OM without any replacement can weaken structure and make soils more vulnerable to erosive forces like wind and water. Consistency is related to structure in that it describes the result of subjection of aggregates to some manipulation such as pressure (e.g., degree of brittleness, plasticity). It is a function of texture and clay mineralogy and indicates aggregate resistance and resilience level.

Bulk density (mass per unit volume) gives an idea about how well water and air can flow and the relative ease or difficulty of rooting, among other processes. The density of individual soil particles varies tremendously. It can range from 5.2 for magnetite to 2.6 $g\,cm^{-3}$ for feldspars and as low as 0.9 $g\,cm^{-3}$ for OM. Higher bulk density indicates less total air space and can be a sign of soil compaction and slower permeability. It is hence closely related to porosity, which is the total air space (pores) between solid particles, and to permeability, which refers to how easily water and air can infiltrate (Gerrard 2000, 29–31). There is often an inverse relationship between porosity and permeability because higher porosity tends to occur with a greater number of micro-pores ($<0.2\mu$m), which, for example, hold water too tightly for many organisms. Porosity is then typically inversely related to texture, meaning that the finer the texture is, the greater the porosity (total pore volume). Smaller particles have greater surface area per unit volume, but have smaller pore spaces between them. Coarser (e.g., sandy) texture typically leads to larger pores, but less overall porosity because there will be fewer pores in total, even though they will be bigger.[3] The bigger the pores are and the more they are interconnected, the more that water and air can move through a soil. So, it is not just the pore diameter or average distance between pores that counts, but also how well pores are connected to each other and this can be determined by micro-morphological (analysis under microscope) or inferential methods (Jungerius 1964; Schaetzl and Anderson 2005, 22–31).

Chemical Properties

There is much dynamism to soils, besides the lively bustling of organisms, and that is due to a variety of chemical reactions. Many occur faster than our eyes can blink but their consequences accumulate to the point of changing soil characteristics. Soil chemical reactions happen both within and between soil aggregates and water. Much of what is understood as soil fertility has to do with chemical properties. The major ones are OM, pH, cation exchange capacity (CEC), buffering capacity, salinity, sodicity, carbonate content, and the levels of iron and aluminum oxides and hydroxides.

OM is a key ingredient, even if often oscillating between only 1 and 6 percent of soil volume and typically restricted to the uppermost horizon. OM constitutes both a physical and chemical trait, but it is not so much its occurrence in a soil that makes a difference as much as the chemical processes that it implies and enables and the often beneficial characteristics it imparts. There are two phases to OM: the residue added following the shedding of material from organisms (e.g., fallen leaves) or the death and decomposition of organisms, and the well-decomposed component incorporated into soils, or humus. As organisms decompose OM, nutrients like nitrogen and phosphorus are released into soil water, which is the main conduit for plant nutrition by way of roots. The less decomposable material builds up over time, sometimes forming layers of organic materials on the surface. In the case of more resistant material, it is accumulated as humus, a term that covers many amorphous and microscopic organic substances that often bind strongly to clay particles. As humus forms, CO_2 and organic acids are released and accelerate the weathering of minerals, which is one way in which nutrients reach soil water. Humus can last for centuries and serve as long-term storage for many nutrients, as well as carbon. In this way soils play a major role in climate change as long-term carbon sinks and, when OM is exposed at the soil surface and broken down, as carbon emitters. Because it creates many pores per unit volume, OM improves water infiltration and also acts as a sponge, raising the water-holding capacity (especially in sandy soils) through its very high specific surface area (total surface area per unit mass). This latter characteristic is also what makes it a large storage component for nutrients (high CEC) and a frequently effective buffer against heavy metal contaminants and, with its lipophilic fraction, organic pollutants like PCBs. Finally, among other contributions, OM reduces raindrop impact (decreasing runoff and flooding), favors the stability of aggregates (soil structure), thereby countering erosive forces, and provides multiple soil habitats (contributing to raising biodiversity). It is therefore tough to exaggerate the importance of soil OM (Brussaard and Juma 1995; Duxbury, Smith, and Doran 1989; Gobat, Aragno, and Matthey 2004; Magdoff and van Es 2000).

Among the most important factors governing soil chemical reactions is pH.[4] Riding on pH is whether and what kinds of nutrients or other elements or compounds (e.g., heavy metals) will be readily available for organisms (mainly in soil water). Acidity, or low pH, for example, creates the conditions for many heavy metals, especially aluminum (e.g., Al^{3+}), toxic to many organisms, to get into soil water and thereby into above-ground plants and soil organisms. Some major plant nutrients become less available with changes in pH either to alkaline or acid values. Nitrogen used by plants, for instance, comes in the forms of nitrate (NO_3^-) and ammonium (NH_4^+). When conditions are acid ($pH<6$), NH_4^+-N predominates, which makes it more difficult for plants to obtain other nutrients like potassium (K^+) and calcium (Ca^{2+}). Phosphates (PO_4^{3-}) tend to bind with Ca^{2+} in alkaline conditions and be less available to plants. Because many soil organisms cannot cope well under acid conditions, fungi tend to become more prevalent with low pH. As a result, soil and above-ground ecosystem composition can vary according to pH (McBride 1994; Sparks 2003; Sumner and Noble 2003).

Soils are quite a lively labyrinth. Elements and compounds migrate continuously, as implied when discussing pH (e.g., hydrogen moves onto and away from soil particles) and mentioning root absorption of soil water. Microbes, fungi, and other organisms also move elements and compounds about by ingesting or expelling them and by enabling the mobility of elements and compounds by breaking down or transforming materials. However, the elements and compounds' own characteristics also influence where they end up. They have, for example, different sizes and often exist as ions, possessing a charge, either positive (cation; e.g., K^+, potassium) or negative (anion; e.g., NO_3^-, nitrate).[5] This is important because charge affects whether elements or compounds will bind with or dissociate from OM, clays, and other minerals, or typically clay-humus complexes, which usually have positive or negative charges on their surfaces. Cations have greater affinity for and tend to migrate towards negatively charged surfaces, which repel anions. When bound to minerals or organic substances, cations and anions remain attached (adsorbed) until conditions change, like a temporary drop in pH or the addition of ions in the soil water. Then they may drop back into the soil water (desorption) and be taken up by a root or fungal filament (hypha) or by a microorganism, which induces the movement of other ions from the humus, clay-humus, or mineral surfaces to the soil water. Or cations, for instance, can serve to attract other ions and act as a bridge (ligand) to the organic or mineral substrate (e.g., linking anions like PO_4^{3-} to an otherwise negatively charged surface, which would reject anions).

The constant interplay of centripetal and centrifugal forces (especially through microorganisms) and the characteristics of soil particles determine to a large extent the kinds and amounts of ions that will be stored in soils. This chemical property is called exchange capacity and is divided into Cation Exchange Capacity (CEC) and Anion Exchange Capacity (AEC). It is the pH-dependent capacity of soil particles to retain cations and anions in general while exchanging them for other cations and anions in the soil water. Exchange capacity is typically measured as milliequivalents (meq) or in centimols of charge ($cmol_c$) per kg of oven-dried soil (the two units coincide in numeric expression).[6] The amount of ions that can be held mainly depends on pH and the combined specific surface areas and extent of chemical reactivity of OM and minerals (i.e., the soil particles).[7] Usually, it is CEC that gets the most attention because most plant nutrients are in the form of cations so that CEC can indicate soil fertility. CEC, for a given pH, can also be useful in estimating the degree to which a soil will prevent cations like many heavy metals from getting into soil water readily and move downward into groundwater. Noteworthy is the tendency for CEC to rise with higher OM content and/or more reactive clay minerals like montmorillonite (Buol et al. 2003; Ellis and Mellor 1995; Gerrard 2000; Schaetzl and Anderson 2005).

CEC affects soils' buffering capacity, which is the degree to which a soil can withstand the addition of acids or alkaline materials without drastic changes in pH. The higher the CEC the greater the buffering capacity and the more that acid or basic material is required to cause a change in pH. Exceeding buffering capacity often means the occurrence of imbalances, at low pH, between cations that are exchangeable (on or very near the soil particle surfaces) and the cations in the soil water. This is when hydrogen and aluminum cations will start kicking off other cations, usually plant nutrients like calcium, which then move downward in soil water (leach) and away from plant roots' reach (McBride 1994; Sparks 2003).

Buffering capacity can be overwhelmed by the accumulation of alkaline materials. These compounds, if concentrated, can alter soil properties like CEC and soil structure. Among the most impacting are water-soluble salts and sodium.[8] Salt content is measured as salinity, estimated by electrical conductivity and elemental analysis. Some soils accumulate high amounts of sodium (Na^+), which can be toxic to most plants, can reduce air and water movement, and can also destroy soil structure (it is a very effective dispersive agent). Sodium levels are quantified as sodicity, which is the percentage of sodium relative to CEC. The occurrence of high salt and/or sodium concentrations is typical of arid zones, where evapotranspiration is high and rainfall is not enough for salts to be dissolved and dispersed (Buol et al. 2003; Hillel 2008; Szabolcs 1998).

The relative abundance of carbonates (CO_3^{2-}) and hydroxides and oxides of iron and aluminum also rank among major chemical soil properties contributing to overall CEC and buffering capacity. The first, besides affecting salinity, contributes to moderating pH and tying up many heavy metals and certain nutrients, especially phosphate, rendering them less available to organisms, including plants. Hydroxides and oxides of iron and aluminum also contribute to this process of preventing many heavy metals from getting into soil water. Iron based compounds, through their color, can additionally give clues as to the state of a soil. For example, reddish or rust spots are a sign of greater oxygen flow (good aeration, oxidation) and bluish and/or greenish ones often reflect the opposite (poor air and water flow, reduction). One can estimate the usual depth of a water table by noting the depth where these kinds of spots abound. In contrast, aluminum based compounds, among other things, can reduce bulk density and raise CEC, depending on the compound and its relative amounts (McBride 1994; Sparks 2003).

These are but some of the main characteristics of soils. The permutations of such properties can give rise to differing characteristics, horizons, and, ultimately, a great variety of soil types. Many of these characteristics are interrelated, so it is not always necessary to take stock of all possible soil properties imaginable, especially when there are constraints over how much lab analysis or field inspection can be done. For example, if a soil is rich in carbonates, the expected pH would be on the alkaline side (high pH) and salinity would also be expected to be relatively high, depending on how long the soil has been exposed to precipitation (which typically dissolves and flushes down salts, like carbonates). Yet it must also be borne in mind that soil properties are dynamic and prone to change, some over minutes or fractions of seconds (e.g., cation exchange), some over years to decades (e.g., OM, structure, and pH), and some others over centuries and millennia (e.g., texture, mineralogy). In other words, soils have intrinsic properties that emerge during the course of their formation and these properties are interrelated and change at different speeds (Markewitz and Richter 2001). Human impact can modify and accentuate soil formation and the rate of change of some soil characteristics, but, unless entire soils are removed, people cannot alone determine the threshold conditions and the set of interactions occurring at multiple time scales that produce soil characteristics, not even for industrially produced soils.

SOIL QUALITY ACCORDING TO INSTITUTIONAL SCIENTIFIC ACCOUNTS

Soil degradation is a relative term, predicated on comparisons with what are understood as stable or functioning soils. Conceptually, it is underlain by soil quality notions (e.g., Lal et al. 2004, 18), which are therefore important to examine critically because they imply standards against which to judge whether a soil is degraded. For many soil scientists, soil quality is good when three broad and intertwined functions are fulfilled: supporting organisms above and below ground (some limit this to plant growth); processing exchanges of matter (by filtering, movement, cycling, buffering, and altering substances); and providing habitat, thereby enabling biodiversity. When any of these functions is hampered, overall soil quality decreases (Blum, Warkentin, and Frossard 2006, 4–6; Kimpe and Warkentin 1998, 4–5). However, the vagueness behind such concepts (e.g. soils as support of all organisms always?) and the wide range of relatively innocuous forms of human impact allow for greater interpretive variety than assumed.

Many indicators are used to evaluate the state of soils and they can be quantified and combined to calculate an index of soil quality (see Bone et al. 2012 for a thorough review). The parameters often regarded as of primary significance are divided according to the main soil properties (biological, physical, and chemical). OM content is associated with all soil property categories in different ways and so its measurement is of central importance (Doran and Parkin 1996). Biological indicators include such data as earthworm counts, respiration (measurements of CO_2 emitted by organisms from within soils), microbial diversity, and nitrogen that is potentially bioavailable (mineralizable). Chemical indicators are covered by such estimates as pH, nutrient content, CEC, and electrical conductivity. Physical indicators encompass water-holding capacity, the stability of soil aggregates (structure), bulk density, porosity, and infiltration capacity. These indicators can be weighted according to their respective preponderant influence in specific contexts (e.g. pH values are more indicative of soil quality change in sandy soils, which usually have less buffering capacity). They are measured to monitor long-term, rather than seasonal trends and are founded on reference or standard values so that change can be detected and compared. The indicator values are based on the comparison of three conditions for a given soil: (1) its “natural” status, (2) its changed character due to prior human use, and (3) its alteration with recent or current human impact (Andrews, Karlen, and Cambardella 2004; Doran 2002; Seybold, Dick, and Pierce 2001; Schjonning, Elmholt, and Christensen 2004).

Putting Soil Quality in Context

Given the great diversity of soils and of social contexts, no single set of characteristics can capture the state of a soil, relative to its ecological functioning and (tacitly and problematically assumed) social parameters. Some soils can be expected to contain a lot of OM, like those developed under grassland, but it would be inappropriate to expect the same out of other soils formed under coniferous forest. Forest soils with relatively low pH and OM may be fine for one society, where gathering wild foods, hunting, and timber extraction play a prominent role, and a hindrance to another more agrarian society, where higher soil OM and pH would be more beneficial to growing crops. These banal observations should be sufficient warning against assessing soil quality as if independent of people’s use of or ideas about soils. Yet these are exactly the assumptions that underlie definitions of soil degradation and they converge with the often implicit subordination of soil concepts under an industrialized, profit-oriented farming perspective.[9] These assumptions even imbue explanations in social science explanations. For instance, inadequate soil fertility for vegetable farming, instead of capitalist pressures on farmers, is invoked as a main cause for a switch to chicken raising in the Delmarva Peninsula (US) in the early 1900s (Striffler 2006). As discussed in Chapter 6, leftists have not been immune to this poor line of reasoning, especially regarding issues of soil fertility. The pervasiveness of notions of soil quality and its political ramifications remain underappreciated. For soil quality to be useful, it must be placed in context, both historical and geographical. In this manner, soils can be assessed in ways that can be applied in diverse situations.

Critique of Existing Official Soil Quality Concepts

Inspecting technical discourse critically can help expose social assumptions and political agendas (Engel-Di Mauro 2006). Mainstream views of soil quality, for instance, have changed from a focus on conventional maximum crop yield to regarding soils through a more ecological perspective (e.g., USDA-NRCS 2010). This more recent ecosystem-oriented concept of soil quality has even gained institutional backing, as in the European Union (via the 2006 Soil Thematic Strategy) and in the U.S., where it is defined as “how well soil performs all of its functions now and how those functions are being preserved for future use” (USDA-NRCS 2010). This departs from the more detailed concepts proposed and evolving prior to and since its simplified restatement within a branch of government. Earlier renditions focused on productivity (e.g. Fullen and Catt 2004, 2; Stocking 1995, 223) and saw soil degradation as the “diminution of soil quality (and thereby its current and potential productivity) and/or a reduction in its ability to be a multi-purpose resource due both to natural and man-induced causes” (Lal, Hall, and Miller 1989, 51). This definition then shifted to “the decline in soil biomass productivity through adverse changes in nutrient status, OM, structural stability, and concentrations of electrolytes and toxic chemicals” (Lal and Stewart 1990, 331; see also Scherr 1999, 5). Doran and Parkin (1996, 11) opt instead for an environment and health perspective to soil quality and introduce a boundary component, extending the definition of soil quality as:

> The continued capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain biological productivity, maintain the quality of air and water environments, and promote plant, animal, and human health.

Place-specificity is given its due, with human needs treated separately and extended to dwelling requirements when soil quality is defined as

> the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation.
>
> (Karlen et al. 1997, 4)

Finally, Lal et al. (2004, 18) view it more succinctly as "determined by the interrelationships among soil properties, soil type, land use and management," where apparently land use and management simply happen and require no further analysis.[10]

Regardless of the respective weaknesses of these definitions of soil quality, they contrast one another in ways that suggest a progressive admission that humans are the ultimate protagonist in this pedological play. It is not just any biological productivity, but productivity that also promotes human health, and then finally the needs associated with habitation, as if it could be independent of human health. Even the spatial aspect is specified, so that it becomes evident that places have some sort of extent (boundaries). Eventually, it is made evident that it is all relative to a combination of decisions over what to use soils for and what the soils themselves are like.

There are many problems with these views on soil quality and they largely stem from subsuming political questions under external biophysical processes. There is no relational understanding (high soil quality for one species can be poor soil quality for another), no discussion of the social context of soil quality knowledge production, no consideration for the possibility of contradictions between human species-specific needs (or even those of other species) and overall biomass productivity, no explication about what count as legitimate uses of soil (who is to decide on land use and management, for instance), no regard for conflicting soil uses, and no recognition of boundaries as socially constructed rather than given.

Regarding the vagueness about organisms supported by soil functions, there is an underlying tension on the inclusion of nonhuman forces (organisms other than people also can degrade soils relative to other organisms' needs) and whether ecological consequences should be incorporated that are at best indirectly relevant to human well-being. For example, the reduction of soil pH, under temperate humid climates, is often more supportive of fungi and other acidity-tolerant organisms. It seems inappropriate to understand soil acidification solely as a form of degradation, although it certainly can be. It is also curious that many other life forms (e.g., fungi, archaebacteria) are excluded from those that are supposed to benefit from higher soil quality. One need not resort to speciesism arguments to find problems with the ways in which soil quality is currently conceived. Life forms have survival needs that may diverge substantively. Allusions to biological productivity or ecosystems merely evade the issue of the status of soils being always relative to a type of society and to the physiological needs of a single (human) species (two aspects that may also contradict each other, especially in a capitalist mode of production).

There is no attempt to confront the possibility of contradictions between human uses and soil functions for the rest of an ecosystem. An example is the expansion of paved areas with the spread of industrial infrastructure that has the effect of sealing or destroying soils and preventing alternative uses, such as farming. These are considered impacts leading to soil degradation, but one could argue that there are inadequacies in the definition due to a lack of attention to social processes (and implicit presuppositions of what is generally desirable for society). For example, hospitals (support for human health), entail the physical degradation of soils through similar outcomes of soil sealing by way of buildings, roads, and parking lots. Another illustration is supporting human habitation in the form of large housing complexes with extensive soil sealing by asphalt and cement. This might not sustain plant and animal productivity, but they do benefit human health (for some people more than others, when it comes to capitalist systems).

This brings in the issue of what constitutes legitimate use. Notions of productivity are at times so narrowly conceptualized as to exclude many communities' livelihoods (and values) based on different uses of soils, such as gathering manoomin (wild rice, *Zizania palustris*) in lacustrine coastal wetlands among the Ojibwa (Vennum 1988). The productive potential of wetlands defined according to manoomin harvests diverges considerably from productive potential relative to agrochemically intensive rice paddies. As for human needs and soil quality more broadly, the example of human habitation can serve as illustration. The human habitation of some people can be destructive of soils (e.g., blocks of flats), while that of other people (e.g., huts made of local rapidly biodegradable materials) can be relatively benign. To claim generically that soil quality is to be supportive of human habitation is to pretend away societal difference and political questions about soil use. This is related to the matter of land use conflicts, which often involve soils. Some people are displaced and are compelled to destroy soils to be able to have homes, but this is implicitly made unimportant in soil quality assessment, even if the socially oppressive processes of forced displacement can be a main source of soil degradation.

Finally the spatial extent of soil quality is typically treated in cavalier fashion. Some fashion boundaries out of ecosystems, a notoriously arbitrary demarcation, and some out of existing land use, implying an acceptance of the status quo. Some like to exacerbate the problem by pretending that ecosystem and land-use boundaries happily coincide (Karlen et al. 1997). These largely unrecognized problems demonstrate that, to make sense of soil quality, social criteria (e.g., modes of land use and distribution and the power relations subtending them) must be included in the determination of indicators.

Political Assumptions and Ramifications in Soil Quality Indicators

Technical constructs are not socially neutral. Presenting them as such is deceptive, as shown regarding acceptable soil loss tolerance values, or the T factor in soil erosion analysis (Blaikie 1985, 17). Perversely, instead of favoring the development of socially critical awareness of such indices, critiques of the T factor have spurred the development of soil quality indices containing similarly questionable assumptions. Indicators of low quality in one context become indicators of fine quality in another. Consider the use of pH as soil quality indicator. The USDA-NRCS (2011) have set the optimal pH range at 6.0–7.5, which is a range useful for growing most temperate climate crops and amenable to many grassland ecosystems. However, wetland soils, such as bogs, and soils under often coniferous forests (e.g., Podzols) have lower pH and nonetheless thrive as ecosystems. Similarly, OM content cannot be judged according to a single standard. Some soils have little OM because of high OM turnover, compared to many soils in temperate environments (Tiessen, Cuevas, and Salcedo 1998). It would be absurd to give a low soil quality score on account of characteristics such soils cannot possibly possess. Sojka and Upchurch (1999, 1045–1047) and Bouma (2004, 290–291) provide further examples of such regional and taxonomic biases.

This issue, arguably, could be resolved by specifying the context in which soil quality is being determined and making soil quality scores specific to the area studied (see Stocking 2003). This does not resolve the problem of conflicting interpretations, a conflict that should impel scientists to honesty about their politics. To some extent, awareness is rising over these problems, but any greater candor displayed relative to interpretation is not as yet commensurate with any greater admission of political commitment. For example, comparing analyses of stored samples from 60 years ago in California to results from resampling, De Clerck, Singer, and Lindert found an overall increase in plant-available phosphorus. Siding openly with conventional farming, they "do not interpret the observed changes to indicate any significant decline in soil quality" (De Clerck, Singer, and Lindert 2003, 226). The interpretational problem is presented as a matter of either pollution (presumably of nearby surface waters, leading to eutrophication) or nutrient enrichment. The dichotomy, the authors' own artifice, ignores ecosystemic interconnectivity and social context. Since soil phosphorus enrichment can mean the degradation of irrigation water (even groundwater, as phosphorus is leached once soils become phosphorus-saturated), the historical rise in plant-available phosphorus is a concern even for conventional farming. Further complicating the interpretation is the potential for manure applications, often used in organic farming, for high soil phosphorus levels (Whalen and Chang 2001). It is not mineral fertilizer that should be at issue, but the authors' reductionism and mystification. One aspect is relative to soil-specific processes (Bennett, Carpenter, and Caraco 2001; von Wandruszka 2006). Rising plant-available phosphorus levels are only meaningful when compared to the amounts of phosphorus soils can store, as influenced by pH, the abundance and types of clay minerals and OM, and iron oxide and carbonate content, among other factors that can also be altered by people (e.g., additions of lime to raise pH, which can lead to enhancing phosphorus availability or reduce it, if pH exceeds 7.3). In the case of the California study, the phosphorus enrichment noted for the Southern and Central Coast regions (De Clerck, Singer, and Lindert 2003, 228) may therefore not be a positive development even for conventional farming because the pH has also increased to levels high enough (7.86 and 7.70 respectively) for phosphorus to be in a form largely unavailable for crops.

It should be the least expected of soil scientists to connect soil quality determination to historically-specific soil properties and to wider ecosystem processes. In the above example, this would translate into linking soil phosphorus levels, organisms and nutrient cycling, and water resources. But since soil quality enters the realm of land use, which also influences some key soil properties (e.g., pH and OM), there must also be due attention to social processes. Taking farming as a point of departure, as the above and many other authors do, is no neutral act. It precludes consideration of other kinds of food-procurement, such as pastoralism or gathering-hunting. Even within farming, there are crucial differences. It is not just whether there is nutrient enrichment. At issue is also, for example, what kind of fertilizer management and what crops and amount of productivity are assumed more useful. By interpreting increasing soil phosphorus levels as showing long-term soil quality improvement in California, the authors unabashedly align themselves with industrialized, capital-intensive farming and the social system on which it rests. Using manure from locally raised livestock, even when involving landlord-based oppression, does not have the same social basis or extent of damaging effects as mined mineral phosphorus, with its often imperialistic and colonial underpinnings (such as the case of the Saharawi struggle, involving Moroccan colonialism and US and French government support; Lakhal 2012). The crop management scheme favored by excessive phosphorus use is embroiled in a form of agriculture geared towards profit-making, rather than feeding people, and this is increasingly understood among some scientists (e.g., Bennett, Carpenter, and Caraco 2001), who demonstrate not only the widespread problem of eutrophication-inducing phosphate fertilizer use with industrialized agriculture, but also the uneven phosphate application according to economic standing (the wealthiest dumping or compelling the dumping of the most phosphate on soils). In the context of California, with a history of colonial conquest, genocide, and land and water theft, whereby colonizers' farming methods ("conventional agriculture") were imposed and eventually developed towards farmworker-sapping profit-oriented agriculture (Lindsay 2012; Walker 2004), opting for one interpretation of plant-available phosphorus over another cannot be presented as mere technicality except out of sheer ignorance about the kind of society in which one lives.

Given the above, comparisons of soil quality scores must consider the ecological and social context of the indicators and weigh such scores as at least in part political questions. Such parameters are considered neither by institutions like the USDA-NRCS, nor by soil scientists critical of soil quality indices. Yet even if the penchant for reducing the world to the needs of temperate zone profit-oriented cereal cropping systems were to be overcome, the problem remains with respect to evaluating the effects of conflict over land use. To illustrate, when cropland is turned into a pine and spruce plantation or into a wetland in a temperate humid area, pH can decline (acidification) after several decades (Kirk 2004, 210; Pallant and Riha 1990). Arguably, this cannot be said to be an issue of soil degradation because a new, lower optimal pH range should be used to make the soil quality assessment. Conversely, if a Podzol developed under coniferous forest were to be used for growing cereal crops, the pH would need to be raised and the soil quality assessment criteria should accordingly shift. Yet the former example would likely count as acidification, while the latter would be considered soil quality improvement in current soil degradation estimations. There are here already several problems that cannot be resolved by invoking soil quality indicators. One is that basing soil quality (at least partially) on the effects of prior soil use is a political notion, something that Bouma (2004) among many others see as a neutral endeavor when it actually amounts to taking the side of a particular form of land use (this is also part of the difficulty, if not farce, of baseline approaches). Another is the lack of consideration for the possibility not only that land use is an outcome of struggle (a political process), but that its consequences, such as introducing an agrochemicals intensive orchard, may have lasting effects stymying other types of subsequent use.

Instead of seeking to contextualize scientific terms and practices, critical reactions from some soil scientists to the soil quality concept have been expressed on the basis of technical standardization problems or of maintaining value neutrality and fears of misinterpretations by "non-scientists." It is difficult to take such critiques seriously when the same scientists clearly take the side of agrochemicals intensive farming (De Clerck, Singer, and Lindert 2003) or of "enabling resource management policy"—a value judgement about the role of science and an implicit political alignment with state institutions—and interpret (or, rather, reduce) science to the establishment of objective facts—a value judgment about what science ought to be (e.g., Sojka and Upchurch 1999, 1039–1040). In a rare introspective foray into soil scientists' social role, Bouma (2004) bemoans soil scientists' alienating technocratic attitude (stated diplomatically as a dearth of "reflexive objectivity"), but falls too short of recognizing processes of ideology and power by ingenuously envisioning soil quality indicators application in land use decisions as one of negotiation. The manner whereby people are included in discussions on land use and its soil quality effects is rarely if at all socially inclusive (the issue is also about how the range of stakeholders is decided in the first place) and there is typically great power asymmetry among those involved in such discussions. As a result, such critical evaluations of soil quality miss the main problems entirely, precisely (and ironically for our well-meaning Bouma) out of a lack of reflexivity. When scientists formulate what they deem to be objective or neutral definitions, they are simultaneously involved in the reproduction of particular ideologies. It should be patently obvious to soil scientists themselves that they are taking sides, but acknowledging this undermines the ideological apparatus out of which they are collectively benefiting. In this respect, the eco-social context of soil scientists is as important as the soil quality indicators measured.

An end to a pretense of neutrality would be of scientific and wider social benefit, so as to promote open discussions on political positions (e.g., about land use), the scope and basis of science, and the role of scientists relative to the state and the rest of society, among many other unspoken, yet underlying issues. Doing this would be conducive to, for example, reducing the social biases in soil science that keep muddying attempts at relating soils to society in constructive ways. Ultimately, the issue of soil quality is a "social problem" (Blaikie and Brookfield (1987, 1), tied to and guided by understandings of human requirements, understandings that also vary according to social context, including ideological processes.

Reducing Soils to Capital Accumulation: Soil Quality as Ecosystem Service

Yet the social problem is an overwhelmingly profit-oriented one (for a state-socialist variant, see Engel-Di Mauro 2006) and this is seldom recognized (see Magdoff 2007 for an exceptional contribution). The evolution of views on soil quality outlined above parallels and responds to changes in the most powerful capitalist state over the past three decades, with the introduction and spread of sustainability concepts, coupled eventually with ideas of resilience (e.g., Lal 1994; Johnson 2012). Such a close connection between mainstream soil science and wider institutional discourse[11] is evident in the recent introduction of the concept of adaptation in soil management (e.g., Lal et al. 2011) and the transformation of soil functions into "ecosystem services" (e.g., Lal et al. 2004, 18; Wall et al. 2012). This is being forcefully promoted through international agencies as well. In July of 2012, for example, the International Atomic Energy Agency and FAO jointly convened a symposium on "Managing Soils for Food Security and Climate Change Adaptation and Mitigation,"[12] where discussions entertained the use of measuring ecosystem services to assess soil management prospects.

The notion of ecosystem services poses a marked contrast to ecosystem functions. An ecosystem presumably can function with or without one of its components (unless a single species is crucial to overall ecosystem stability), so one can still regard an ecosystem beyond the requirements of a single species. Primary attention is to ecosystems, rather than their component parts. To transform functions into services requires a shift in focus from the requirements of the whole to those of one its component parts. To put the matter differently, services beckon the question of what or who is being serviced by what or whom. Following the official definition, this is rather clear: “Ecosystem services are the benefits people obtain from ecosystems” (Hassan, Scholes, and Ash 2005, 5). The purpose of all other species and physicochemical processes is to cater to human benefit. One should then wonder whose needs and when, since needs to some extent differ among societies and change over time. If it were left to a matter of benefiting, there could be a chance to discuss ecosystem services with respect to social needs. But such is not the case. The concept of ecosystem services, introduced in the 1980s as a didactic tool, eventually became an accounting medium for capitalist ends, i.e., for profitability (Peterson et al. 2010). The delirium of commodifying ecosystem functions is exemplified in a recent UNEP study, where cost-benefit analysis can only be envisioned in bourgeois terms:

> in the [Millennium Ecosystem Assessment], nutrient cycling is a supporting service, water flow regulation is a regulating service, and recreation is a cultural service. However, if you were a decision maker contemplating the conversion of a wetland and utilized a cost-benefit analysis including these three services, you would commit the error of double counting. This is because nutrient cycling and water regulation both help to provide the same service under consideration, providing usable water, and the [Millennium Ecosystem Assesment]’s recreation service is actually a human benefit of that water provision. An analogy is that when buying a live chicken you do not pay for the price of a full chicken plus the price of two legs, two wings, head, neck etc . . . you simply pay the price of a whole chicken.
>
> (Fisher, Bateman, and Turner 2011, 5)

The multiple uses and functions of an ecosystem—not just by people, but by other organisms—are indeed too much for our erstwhile poultry chrematistics experts. The price of a wetland has as much to do with a wetland as a chicken’s price with chickens. On what basis is one even in a position to sell a wetland or a chicken? The only accounting error here lies in the bourgeois economist’s inability to grasp what counts and on whose terms. Prices for organisms like chickens, physicochemical processes like nutrient cycling, and, of course, wetland soils, reflect nothing but the outcome of some people’s power to exclude other people from the necessities of life, if not the ecological conditions of others’ existence. Our “decision maker,” endowed by our cavalier bourgeois ideologues with the power to have a wetland ravaged at will, is the ultimate despot. When buying the services of a bourgeois economist, you simply pay the price of lunacy.

Conceptually, ecosystem service is an updated version of an instrumentalist view of nature already identified by Merchant (1980), among others, as part of the development of capitalism. What demarcates this recent ideological move is a direct attempt to treat everything as an exchangeable commodity, reducible to market valuation (Mies and Shiva 1993; Peterson et al. 2009). Neil Smith (2006) identified this process as the creation of "ecological commodities" via new impositions of scarcity (e.g., wetland mitigation banking, Robertson 2004) that paradoxically came out of environmental movement pressures (and I would add pressures from associated or concerned scientific communities). Arguably, one can trace soil commodification at least to the late nineteenth century, when soils started to be treated as products to be manufactured for market sale (Bunt 1976, 15, 150–151). By the 1930s, the process extended to soil degradation through monetary equivalent calculations (Bennett 1939; Brown and Wolf 1984; Pimentel et al. 1995). What soils experts and many other scientists and environmentalists fail to grasp is the impossibility of accounting for soil losses (or environmental degradation generally) by using a historically recent and contingent valuation process (e.g., pricing) based on the outcomes of activities and perceptions of some populations from a single species (i.e., those involved in capitalist market transactions) and on belief systems (capitalist cultures) that are not universally acceptable or applicable. In capitalist social relations, simply put, those selling clods of soil are the ones receiving payment, not the soil. It is not soils but people with economic power (money, property in manufactures and/or means of production) that determine what soils and even people are worth (their market or exchange value). When soils are degraded, it is not the soil itself that tells us how much they are now worth. It is people empowered with buying and/or selling (and the outcomes of their often bloody profit-seeking conflicts) that dictate such value (as costs or prices).

Monetary delusions aside, there are at the same time ecological repercussions to soil manufacture and sale that seem still little appreciated even by monetization-happy scientists. Materials assembled for manufactured soil are not just for potting plants. There are enormous quantities used for projects like residential and commercial construction and infrastructure projects, like motorways. Much of the material still comes from mining other soils, especially peat (a type of wetland soil), but also sediments (e.g., clay, sand, gravel) and petroleum by-products (e.g., plastic foams). Increasingly, composted "biosolids" (sewerage sludge) are being used, and some firms are pushing to gain a larger share of the topsoil market by specializing in such recycling

(Cole 1997). This has become a controversial issue, since topsoil made from sludge can contain contaminants, such as heavy metals and dioxins, and be therefore a source of airborne contaminant and unsuitable for crop production (Bhogal et al. 2003; Nabulo, Black, and Young 2011). Production and use of topsoil can thus be simultaneously a process of degrading soils (in the phase of extraction and production) and producing long-term soil and broader contamination problems (in the phase of transport, storage, purchase, and final application). Selling potting or imported soil has become commonplace in the largest capitalist markets, like the U.S. (see, e.g., http://dirtexchange.us/). Ascribing market value to soils might not be so novel, but its consequences are now much more wide-reaching and possibly long-lasting.

The overall soil commodification process associated with topsoil markets and the monetary reductionism of soil degradation has intensified over the past two decades, in line with what Neil Smith has pointed out for "ecological commodities" generally, as financial speculators seek to turn arable soil into tradable assets (e.g., http://peaksoil.com/) and soil carbon into an investment opportunity (Bryan et al. 2010; Klare 2013, 201–204; Tschakert 2004). The largely unquestioned acceptance of commodification in scientific circles has eased the introduction of the concept of soil ecosystem services, whereby soils (in their entirety) and the consequences of their degradation are now to be thought of as commodities (i.e., reduced to capitalist uses and objectives). In this sense, the matter is not about potential commodification, as some surmise (Gómez-Baggethun and Ruiz-Pérez 2011), but of active scientific complicity in constructing an ideology promoting the very process of commodification (see also Smith, N. 2006, 25), a thoroughly political project of restricting access to life-sustaining processes and resources—in other words, theft backed ultimately by institutional violence—to favor capital accumulation.

ALTERNATIVE POSSIBILITIES FOR SOIL QUALITY EVALUATION

These implications traverse all current soil quality concepts and estimation parameters (and soil science more generally). They have not been addressed in leftist scholarship except indirectly, relative to the socially contingent nature of what counts as soil degradation (e.g., Bell and Roberts 1991; Blaikie 1985; Brookfield 2001; Grossman 1997; Scoones 2001; Tengberg and Batta Torheim 2007). Alternative indices have not been forthcoming and so they have been left largely to mainstream soil science. Yet a soil quality index or equation could be devised that accounts for context and political struggles over land use (i.e., in terms of deliberation and decision-making about who is to use what and to what end). Indicators can be weighted differently according to ecological situation. For example, lower OM ranges should be used for certain tropical conditions, excluding such soils as those formed through anthropogenic organic inputs or wetland desiccation and being mindful of historical changes (low OM may also be due to past human impact, so that the potential for OM might be higher than at present). However, to include social aspects there has to be at least a grasp of what soil uses (not just market-oriented) exist in an area and indicators can conceivably be weighted according to soil use. To keep to the same example, under tropical conditions that tend towards low soil OM content, it is a decision with political ramifications whether OM levels would need a higher or lower weight in determining an overall soil quality score. One could argue that for gathering-hunting soil use, low OM levels are fine, but agrochemicals intensive farming and some types of tree plantations should require higher OM levels than farming based on organic inputs or permanent-cover plantations (e.g., coffee) or agroforestry, which would be expected to counter low OM trends. The practice of shifting cultivation could also be argued to have similar OM value requirements as gathering-hunting for an acceptable soil quality score. None of these scores on soil quality would do much to address spatial variability in species composition associated with different land uses and soil quality standards, so the matter is intricate even when considering social processes in the most superficial manner and within a restricted scale of analysis.

The complexities involved in quantifying soil quality need not mean that it is impossible to come up with such estimations or models. It is beyond the scope of this work to build a systematic alternative soil quality index that accounts for specific ecosystem dynamics and their differential rates of change, and for differences such as modes of production and power relations at multiple scales (e.g., the socially produced needs and political struggles behind the prerogatives for different types of soil use). However, as a first approximation and in an unabashedly politically committed manner, one can redefine soil quality thus: The extent to which a soil, with given intrinsic properties, nonhuman organisms, and relative degree of human-induced alterations, enables the fulfilment of survival needs of every human being, understood both biophysically and socially. Therefore, optimal ranges and measurements of bio-physicochemical indicators have to contribute to the development or reproduction of an egalitarian society (otherwise, meeting everyone's survival needs is not possible). This means, among other things, taking stock of oppressive conditions and making the effort of finding out what uses of soils are suppressed or denied that would otherwise further the realization of the biophysical and cultural needs of all people living in a given area. This sort of analysis can and should range all the way to the global at the same time that a political struggle is waged in a certain locality. Viewed this way, soil degradation, aside from involving a perceptual change, is a change in soil quality (its bio-physicochemical properties) that constrains or prevents the fulfilment of everyone's survival needs and that undermines the development or reproduction of an egalitarian society. It would take a long-term comparative study to arrive at a concept of soil quality and degradation that incorporates major factors more adequately and that could find general applicability. Still, with the above cautions and potential alternatives in mind and by contextualizing soils in both ecological and social relations, it should be possible to address the issue of soil degradation more effectively than is typically done.

CHAPTER 4

SOIL DEGRADATION: OVERVIEW AND CRITIQUE

Soil degradation is a “quiet crisis” (Brown and Wolf 1984; Lal 1990, 10), a “global threat” (Lal and Stewart 1990), “a silent emergency” (Dowdeswell 1998, xi), “a serious threat to sustainable development” (Chen et al. 2002, 251), a “threat to modern society” (Montgomery 2007a, 2). The view of soil degradation as grave and global is common even among those averse to hyperbole. It is so pervasive as to have captured the imagination of some political ecologists (Peet, Robbins, and Watts 2011, 25). Yet, as discussed in Chapter 3, the soil quality criteria on which this global interpretation rests are decontextualized and often informed by capitalist assumptions. Furthermore, it turns out that the interpretation relies on tenuous evidence and faulty methodology, especially regarding soil erosion. Claims made of or about soil degradation therefore need to be carefully evaluated to understand the actual state of soils and develop political alternatives accordingly.

This does not mean that there is no worldwide soil degradation problem. Compilations of case studies and reports from different parts of the world point to its existence (Bai et al. 2008; Brookfield 2001, 158; Dobrovol’skii et al. 2003; Markewitz and Richter 2001; Montgomery 2007b; Rozanov, Targulian, and Orlov 1990; Russell and Isbell 1986; Sumner and Noble 2003). Even if the consequences on, say, food and fiber production are unclear because of the large number of factors involved (Lal 1990, 10; Nachtergaele 2004), the overall processes leading to soil degradation are also well understood. Mining, dams, bombing raids, large-scale construction, and monumental buildings have literally made entire soils disappear altogether, if not buried or submerged them. Various sorts of pollution from diverse types of industrial processes and waste production have concentrated unparalleled amounts of heavy metals and synthetic organic contaminants in relatively small volumes of topsoil in both city and country (Bennett 1939, 535–545; Davidson et al. 2006; Howard and Olszewska 2011; Iwegbue, Williams, and Isirimah 2009; Kabata-Pendias 2001; Kiernan 2013; Meuser 2010; Simón et al. 2001; Singh 1998; Souvent and Pirc 2001). Some of these are a long-term scourge, lasting decades to centuries (e.g., heavy metals and organochlorines) and threatening people's health across generations. These often carcinogenic contaminants bound to particles dislodged and picked up by wind are ingested daily by millions or they percolate through soils and end up in water supplies. Expansion of industrialized urban areas and infrastructure has meant large tracts of soils permanently paved and compacted, useless for most life forms and harbingers of methane and other foul emissions (Blum 1998b; Bullock and Gregory 1991; Burghardt 2006; Haide and Schäffer 2009). Agrochemicals and capital intensive farming has spurred the continuous and intensifying dousing of soils with biocides and fertilizers, leading to contamination problems, acidification, OM (organic matter) depletion, and biodiversity decline (Barak et al. 1997; Bouman et al. 1995; Ellis and Mellor 1995; Fullen and Catt 2004; Giri et al. 2005; Hooda et al. 2001; Luizao, Bonde, and Rosswall 1992). In some areas with high evapotranspiration rates, irrigation has been carried out in such a way as to induce salinization (Hillel 2008; Szabolcs 1998). Many areas have experienced accelerated erosion rates that can stress if not debilitate food and fiber production and lead to heightened sedimentation and eutrophication of surface waters (Bennett, Carpenter, and Caraco 2001; Blaschke, Trustrum, and Hicks 2000; Braimoh and Vlek 2007; Lal 1990). At the same time, as discussed in Chapter 3, soils have been increasingly manufactured (e.g., turf and potting soil) or have recently formed and developed as a result of direct human impact (e.g., through reclamation of land under water, large excavated basins acting as accidental sediment traps). In some areas, soils have recently been left alone or have been dedicated to other less destructive uses (e.g., Lal et al. 2004), but they have also been used sustainably if not enhanced for at least centuries (Brookfield 2001; Norton, Sandor, and White 2003; Reij, Scoones, and Toulmin 1996; Scoones 2001). These are but some of the salient impacts on soils over the past couple of centuries. Most of them have been destructive and they are often superimposed on the outcomes, degrading (e.g., Boardman 2003; Montgomery 2007a; Turner and Sabloff 2012) but mostly enhancing (e.g., Kaufman and James 1991; Van Smeerdijk, Spek, and Kooistra 1995), of impacts from societies now long gone. Currently, the overall tendency is negative, with respect to soils facilitating human and many other organisms' existence. Soil degradation is an expanding and intensifying problem that is hampering or is potentially undermining people's health or livelihoods, directly or indirectly. However, as with any form of environmental degradation, the consequences are shared in a most lopsided manner and the pressures to use soils in destructive ways result from sets of oppressive power relations that are far from confined to the areas where soil degradation occurs (e.g., Blaikie 1985; Carney 1991; Engel-Di Mauro 2012a).

A major obstacle to addressing soil degradation is, arguably, the manner in which the problem is prevalently acted upon and framed or understood beyond alarmist rhetoric. In short, there is a dearth of sensitivity to ecological contingency, but especially a lack with respect to social relations of domination. The credibility of soil degradation claims and corollary conservation policies is further undermined by a history of recurring dictatorial and counterproductive technocratic practices or of policies privileging economically powerful groups. But it is also the capitalist ideological underpinnings of current soil degradation discussions, especially among scientists, that hinder the development of appropriate measures and techniques to address soil degradation. It will be mainly this ideological aspect that will be the focus of attention here, as the oppressive and/or capital-centralizing nature of soil monitoring and conservation practices has been already ably recounted (e.g., Bell and Roberts 1991; Blaikie and Brookfield 1987; Grossman 1997; Leach and Mearns 1996; Showers 2006).

There is also an uneasy and sometimes contradictory relationship, sometimes related to histories of colonial abuse, between mainstream scientific interpretations and those of people using soils for their livelihood. The variability in perception of and attentiveness to soil degradation has been addressed to some extent in Chapter 2 (especially regarding "ethnopedology"). Such variability already indicates that the basis of determining whether a soil is degraded results not only from studying soil conditions, but also from one's position in society and political convictions. Epistemologically, as with soil quality indicators, to deem a soil degraded is to presume soil superiority or inferiority based on notions of what constitutes optimal use. The exercise is predicated on socially specific criteria (physiological and cultural) relative to time and place. In other words, to expand on Blaikie and Brookfield's (1987) take on "land degradation" as "social problem," soil degradation implies a political position relative to how people relate to soils. This is why the matter of soil quality and hence degradation must encompass a study of social relations, not just soil properties (see also Blaikie 1985, Chapter 4; Scoones 2001, 14). In fact, it is not possible to study nonhuman phenomena without at least some awareness of and attention to the social conditions that guide the process of studying nonhuman worlds (e.g., Barad 1999; Harding 1991; Harvey 1974).

Addressing scientists' production of knowledge about the extent and severity of soil degradation is important for another reason. Much leftist writing and activism relies on and/or critiques scientific reasoning and/or evidence without attentiveness to the details of the discussed topic (e.g., soils) and its associated scientific field (e.g., soil science). If the evidence is unreliable or much more nuanced than appreciated, leftist activism and theoretical claims can be compromised (see Chapter 6). On the other hand, leftist politics are poorly served by critique of or skepticism about scientific evidence without building alternative ways of producing knowledge and/or developing and diffusing alternative ways of interpreting existing knowledge.

In light of existing practices of scientific knowledge production, one should approach soil degradation by, among other things, exposing soil scientists' inattentiveness to social context and questions of power, to their problematic assumptions about society, and to the absurdity of neutrality and objectivity claims. Soil degradation arguments express a political project regarding what type of land use and whose criteria are to be used to gauge whether an impact or activity is negative. But such arguments do not just rest on the dynamics of power in which scientists are always enmeshed. It is a phenomenon both related to and beyond what people do to or say about soils. Learning about what actually happens in soils provides the basis for any notion of soil degradation in the first place. What is less appreciated on the left is that this enables one to expose incongruities between social constructs and nonhuman processes and the political ends veiled by technical abstraction (see, e.g., Stocking 1996, 141). Studying soils is just as important as studying the social relations associated with soil use. By extension, studying environmental processes is just as important as studying the social relations associated with environmental practices.

VARIETIES OF CHANGE IN SOILS

To grasp the problem of soil degradation, it can be useful to return to the topic of what soils are. Soils can be viewed as interactions and assemblages of organisms, air, water, and assorted particles. The interactions among soil components change (e.g., the amount of nutrients going from microscopic soil particle surfaces to organisms or how and how much water and CO_2 flow between soil pores, organisms, and the atmosphere) and so do the components themselves (e.g., tree species age stand, nematode populations, types of clay, or forms of OM). Hence soil internal composition mutates over time. One way of organizing knowledge about changes in soils is according to soil property. In this way, one can think in terms of biological, physical, and chemical change, rather than just in terms of degradation (Table 4.1, expanding upon Dobrovol'skii et al. 2003, S6; Hillel 2008, 198; Lal 1990, 9; Lal et al. 2004, 5). Because change in one soil property reverberates in another, the issues represented by each item are not mutually exclusive. They should be read as directly or indirectly interconnected phenomena within and between the major categories. The reduction of OM may be paired, for example, with soil erosion. Salinization can be associated with some nutrient deficiencies (e.g., iron and phosphorus). There are also instances in which a process of soil degradation exacerbates another. For instance, heavy metals become much more mobile when soils acidify, since many heavy metal elements tend to be soluble (they mix in soil water) much more readily at low pH and transfer more easily into roots and soil organisms.

Table 4.1 Forms of soil modification

General Category	Examples
Biological	Increase or decrease in soil biodiversity Decreases or increases in total biomass and organic Carbon Slowdown or acceleration of nutrient turnover rates Lowering, stabilizing, or raising of rates of organic matter breakdown
Physical	Net erosion or accretion (deposition) of material Loosening or compaction (lowering or increasing bulk density) Water drainage or saturation (waterlogging) Structure (soil aggregate) formation, stability, or breakdown
Chemical	Organic matter decline or increase Increase or decrease in buffering capacity Nutrient depletion or excess Acidification or alkalization (permanent decrease or increase in pH) Salt leaching or build-up (salinization) Heavy metal or radionuclide mobilization or immobilization

As discussed in Chapter 2, soils appear, change, and disappear whether or not people exist or do anything to soils (Dobrovol'skii et al. 2003, S3; Schaetzl and Anderson 2005). Sometimes, like climate change or high magnitude floods, environmental forces are affected by human action. At times, like asteroid impact or volcanic eruptions, they are not. To make sense of changes in soils (or physical environments generally), human impact must be understood as part of a constellation of forces, social and environmental, and as having multiple possible outcomes (positive, negative, or indifferent), depending on context. Separating human impact from that of other factors is no easy task. Not all outcomes of human activity are obvious or directly detectable and their evaluation is not always straightforward. There are gradations of human influence, from the intensification of preexisting conditions (e.g., adding materials to raise pH in a high-CEC soil or cutting a few trees on a slope leading to crossing a threshold and producing a landslide) to direct effects (e.g., raising OM by adding manure or enriching soils with heavy metals through releases from industrial processing plants). The same can be said of the kinds of change in soils that impair the fulfilment of our physiological needs and/or of socially specific objectives. In this case, it is usually called soil degradation.

The Multifarious Nature of Soil Degradation

Soil degradation can be perceived in many ways. For the purpose of clarifying the processes involved in soil degradation as understood in the soil science mainstream, as negative changes relative to human uses, I provide some illustrations systematized according to soil property, as outlined in table 4.1. Then it will be shown how they are interlinked, since their repercussions can only make sense if examined as part of a whole.

Biological Degradation

Biological degradation encompasses changes in soils that negatively affect other organisms and therefore the overall functioning of an ecosystem. For instance, toxic emissions from volcanoes or indiscriminate and persistent biocides and monocultures often lead to reduced biodiversity. The effects of pollution on water and air are typically well publicized, but not so for soil pollution and its consequences. Heavy metal pollution is particularly destructive of soil organisms.

It is estimated that the toxicity from metal contamination can reduce the diversity of soil bacteria by as much as 99.9 percent, even if the total biomass of bacteria is unaffected. It is especially the rare species of bacteria that can be wiped out entirely under such conditions, but the repercussions of their loss on the functioning of ecosystems are mostly unknown (Gans, Wolinsky, and Dunbar 2005). However, given the importance of bacteria, a decline in bacterial diversity can spell bottlenecks in the nutrient cycle, which could harm plants and other below- and above-ground organisms (such as us), whether they feed on bacteria or plants (including crops). And if a soil loses many of the species of bacteria that help make nutrients available to plants, it is likely that many of the functions that bacteria provide will also be lost. Then many plants can be harmed, as well as the organisms that depend on them. This is because it is the diversity of functions that organisms play in an ecosystem—not just the number of species—that determines the health of an ecosystem.

Physical Degradation

Physical degradation is the negative modification of the physical properties of a soil. Soil structure can be altered by the use of heavy equipment (tractors, combines) or the confinement of large domesticated animals. Often, such practices result in compaction. In this case, soil aggregates are pressed into more plate-like shapes, which hinder water and air flow. Crops that do not tolerate waterlogging or shallow rooting depths will grow stunted or not at all (Soane and Ouwerkerk 1994). Water flow and storage can be hampered in other ways, too. The draining of wetland soils leads to their collapse, along with the ecosystem they support. Irrigation in arid areas might improve moisture levels and crop yield, but eventually it leads to waterlogging problems and the build-up of salts close to or even on the surface, killing most life-forms (Fullen and Catt 2004).

Accelerated soil erosion is usually the best-known type of physical degradation. It is defined as the rate of soil formation (weathering and/or additions of sediment) being lower than the rate of soil removal. Erosion occurs regularly, with or without human impact, through the detachment and movement of soil components from one site to another. When soil particles are moved they are known as sediment. When precipitation exceeds soil infiltration capacity, water carries particles away from the soil surface. Similarly, when wind speeds are stronger than the forces of soil particle aggregation, the wind will carry soil particles away. Bare soil surfaces raise dryness and lower soil particle cohesion, so winds can move particles more easily.

The main factors determining the occurrence and degree of erosion can be divided according to factors of erosivity (the strength of wind and water) and erodibility (the propensity for erosion). Wind erosive strength is related to its frequency, magnitude, duration, and velocity. The degree to which rainfall can dislodge (detach) and move (transport) soil particles depends on its duration, intensity, raindrop mass and size, velocity at impact, and frequency. Water erosion occurs as splash (loosening of particles), sheetwash (particles transported through thin, continuous film over a smooth surface), and channeled forms. The latter may occur as rills or gullies (concentrated overland flow in variable width channels) and subsurface channels or piping (Bennett 1939; Bryan 2000; Ellis and Mellor 1995, 241–246; Fullen and Catt 2004, 10–20; Laflen and Roose 1998; Lal 1990, 55–56). Human activities are also a direct force of erosivity, through, for instance, harvesting, tillage, land levelling, and excavation (Boardman, Poesen, and Evans 2003).

Soil erodibility is dictated largely by surface cover (height, structure, and density of plant cover, surface roughness) and slope angle and length. Human impact therefore has much influence on erodibility as well, such as by changing slope geometry (e.g., terracing) or land cover. Forested ecosystems tend to be most effective at reducing erosion rates. However, woods on steep slopes (>40 percent) may not be so effective (Koulouri and Giourga 2007) and splash erosion can be severe even under forests, depending on the distribution and characteristics of sub-canopy vegetation (Geißler et al. 2013; Tsukamoto 1966). Susceptibility to rainfall depends on OM and clay content, root density, and slope angle and length. These affect soil-particle aggregate size distribution, particle cohesion, and soil moisture retention capacity. Crusting (gluing of particles) on the soil surface can minimize wind erosion but augment water erosion, depending on slope characteristics. Slope angle and length are even more directly associated with erosion rates. Generally, longer and steeper slopes lead to high erosion rates, even with plenty of vegetation cover (Bryan 2000; Lal 1990, 60–92, 111–126).

The major consequences of soil erosion are losses of topsoil, depth, nutrients, and water-holding capacity, leading to changes if not declines in organism populations. Soil eroded from one place moves to another, where it may accumulate (sedimentation). Sedimentation can lead to burial of other soils or to infilling of lakes, reservoirs, rivers, drainage ditches, and other land-based bodies of water, harming aquatic ecosystems. Sedimentation rates tend to be raised by erosion, but the redistribution and actual impact of soil-derived sediment is not easy to sort out.

Chemical Degradation

Chemical degradation refers to the alteration of the chemical properties of soil such that there are negative repercussions for the ecosystem of which a soil is part. This negative impact can take many forms. In arid zones, it has often taken the form of irrigation-induced salinization, wiping out most organisms for decades. Other such lasting effects are heavy metal and other kinds of pollution through military activities and industrial emissions, which alter if not fatally undermine ecosystems. Fertilizer saturation and leaching has led to aquifer pollution and the loss of buffering capacity. The latter is linked to acidification through synthetic fertilizer nitrogen applications and also acid-rain inducing industrial air emissions (Barak et al. 1997; Bouman et al. 1995; Sumner and Noble 2003). Prior to the introduction and global spread of synthetic fertilizer, organic materials served as the main source of nutrient replenishment in farming. The substances could be derived from manure (animal feces, including from people), crop and other plant residues, from mixtures of the manure and plant matter, from composted vegetable matter, and so on. Replacing these organic fertilizers with synthetic ones has resulted in lowering OM in cultivated soils and their nutrient- and water-holding capacity.

The Interrelatedness of Forms of Degradation

This last is also an example of how different kinds of soil degradation are interrelated. Reduced OM compromises micro-organisms' survival and their contribution to making stable soil aggregates. This is because a decline in OM means the destruction of habitat for most micro-organisms and a decrease in the amount of OM that would otherwise be inaccessible to microbes that feed on it. When populations of soil life forms dwindle, humus levels start falling as micro-organisms will continue to breakdown existing humus. When there is less food (OM) for soil micro-organisms, fewer microbes can survive and the food source starts to disappear even more rapidly. Soil nutrients and water-holding capacity tend to decrease, as do the binding agents that microbes contribute and that glue or keep soil particles together. And so the soil structure starts to fall apart as well, with the negative effects described above with respect to physical soil degradation (Hayes 1991, 19). As further illustration, repeated treading by machines can turn soil structure in the upper A horizon ("topsoil") from granular to platy (compaction). This impairs water and air flow. Soil and aboveground organisms are affected by hindered rooting or reduced oxygen levels. It is only to simplify a set of very complex processes that it is useful to differentiate human impact according to major soil properties. To make sense of overall impact, it is necessary to assess how all soil properties are affected at once. Soil quality indices can be useful precisely for that purpose and can assist in understanding overall change in soils, but they must be refined, understood politically, and made context-sensitive, as explained in Chapter 3.

THE SOCIAL CONTEXT OF SOIL DEGRADATION

The above description is to give a sense of the great variability and interconnectivity that exists with respect to soil degradation. However, describing soils as degraded implies an alteration of soil properties relative to socially specific uses, not to the general status of a soil. Degradation beckons the question of the frame of reference used. To address this, the social context and position of the analyst and the evaluative criteria employed must all be considered. Yet these basic questions of social context are often relegated at most to afterthoughts. The situation is even worse if one expects soil degradation studies to address social conflict and relations of power, often key to explaining destructive human impacts.

It should be noted that the concept of degradation in soil science is not necessarily associated with usefulness to people or with soils in their entirety. In the study of soil formation, one can, for example, describe as degradation the breakdown of fragipans (Bx horizons), dense (high bulk density) and often brittle layers that tend to hinder downward water flow and plant rooting. It is also often called degradation the transformation and depletion of clays in clay-predominant layers (Bt or Argillic horizons) that can result in the development of a coarser-grained (sandier), quartz-dominated, low-pH, and low-CEC, or an E horizon (Schaetzl and Anderson 2005, 370–380). This implicit ranking of single parts of soils in evolutionary terms is relative to an initial set of conditions selected by the researcher. For instance, already formed plinthite is taken as the point of departure, but one could just as well start from before plinthite formed in a soil and then name plinthite formation a form of degradation.

Terms can only be meaningful in context. However, one could use the term change instead of degradation. The conflation of degradation with breakdown (of ranking system with general process of change) implies an indifference to social context that becomes rather problematic when put to practice. For instance, plinthite breakdown can be quite useful for, among other forms of cultivation, agroforestry (by increasing water flow and rooting depth) and not as useful for rice paddies (since a plinthite layer enhances ponding on the surface). The "degradation" of plinthite is an improvement for one type of use and not for another, but in a privileged context disassociated from such practicalities, the difference between degradation and decomposition is subtle and calling out such difference may seem like pilodectomy.

Soil Degradation and Reproduction of Capitalist Ideology

And scientists, as a result of their usefulness for capitalists and governments, tend to be well rewarded and to live privileged lives detached from everyday struggles for existence. Arguably, this could be one reason for there being such little awareness among scientists about the kind of social system in which they live. There is not much incentive to find out (or, at a minimum, in applying the same scientific principles to studying the society they are part of) and so the usual practice in the biophysical sciences is to take prevailing ideologies for granted, as the norm, and thereby reproduce them. To illustrate the reproduction of predominant ideology in scientific discussions on soil degradation, one can start by bringing under scrutiny current and widely used definitions.

One is from Lal, Hall, and Miller (1989, 52), who recognize both human and nonhuman causes and multiple types of use in their understanding of soil degradation as the "diminution of soil quality," in common with more recent versions (e.g., Hillel 2008, 13). In their view, "it is important to identify the critical limits of soil properties and processes that constrain various uses." The uses are indeed various, yet the discussion is constrained by a narrow understanding of society. The authors divide the world into "agricultural" and "nonagricultural," differentiating "economically-viable" from subsistence farming and seeing "waste attenuation" and "load-bearing" as primary examples of other forms of land use. Apparently, people do not gather medicinal plants or hunt and the economically viable is deemed only what is unnecessary to live (i.e., not subsistence). Similar technocratic varieties of bourgeois ideology surface elsewhere, with often careless or confused borrowings from mainstream economics terminology.

Such beliefs surface more clearly when soils are reduced to farm-production transmission belts. For instance, according to Lindert (2000, 8), soil degradation "refers to any . . . change in the soil's condition that lowers its agricultural productivity, defined as its contribution to the economic value of yields per unit of land area, holding other agricultural inputs the same." Just what kind of economy the author is talking about is no mystery, judging from his valuation in yields per unit of land area. In fact, by reducing soils to farming productivity, the author is not even addressing soils at all. A change in land use from conventional to organic farming can lead to lower yields, but end up improving soil quality, relative to conventional definitions (de Ponti, Rijk, and van Ittersum 2012; Mäder et al. 2002; Pimentel et al. 2005; Seufert, Ramankutty, and Foley 2012). For the likes of Lindert, who cannot tell the difference between soil characteristics and human use, a shift to organic farming could qualify as soil degradation. We are fortunate that he spares us tirades against low-yield farming in his otherwise useful volume, but the political implications of his definition are clear and, as shown in the previous chapter, they are more directly expressed as an allegiance to mainstream farming (De Clerck, Singer, and Lindert 2003).

These implications infuse much of soil science but are usually more tempered and less explicit. Lal (1997, 998) sees soil degradation as "the loss of actual or potential productivity or utility as a result of natural or anthropogenic factors" (cf. Hillel 2008, 13; Wild 2003, 69). The nature of this productivity is specified on other occasions, such as in Lal (1994, 59), who deems a "low output subsistence system . . . economically unsustainable because of low productivity," even if the author recognizes it can have higher energy efficiency and despite subsistence systems having been around for millennia without any problems of economic "sustainability." Sometimes, appeal is made to abstractions like energy flux models that, when shed of function-use conflations and explicated relative to land use, they betray narrow concerns reflecting life in industrialized capitalist society (Blum 1998a, 3–5; Bouma 2004, 291–292). These persist in recent turns towards more ecologically oriented approaches. Lal et al. (2004, 4–5) retain a concern for losses in utility and productivity, but the latter is redefined in terms of quantities of biomass, as part of ecosystem functions that include "moderation capacity." Chen et al. (2002, 244), even enrolling critics like Blaikie and Brookfield (1987), deem soil degradation to imply a reduction in "desired" actual or potential plant production and diversity or, more generally, the impairment of the fulfilment of a "desired function" or use. Just who does the desiring is a matter cleverly left for us to guess. The inclusion of Blaikie and Brookfield's work, devoid of its principal thesis that soil degradation is a social question, amounts to bibliographical garnish (for other such examples, see Boardman 2006, 74; Safriel 2007, 2). Others' approaches (e.g., Hillel 2008, ix; Lal et al. 2004) concur more closely with Bai et al. (2008, 233), who surmise the issue to be one of "long-term loss of ecological function and productivity [i.e., the rate of biomass produced] caused by disturbances from which land cannot recover unaided."

There are two fundamental problems with this quantitative obsession about biomass. First, there is a failure to specify the location of biomass production. Soils and above-ground ecosystem characteristics are not coterminous. If a tropical rainforest on a low-CEC, highly weathered soil (e.g., a Ferralsol) is cut down and/or burned and replaced by a permanent high agro-diverse system or by a temporary farming area featuring intercropping, there would be a fall in total biomass but that would not affect the soil productivity itself, since such a soil tends to be nutrient poor. In fact, according to the same logic in current soil quality definitions, the soil itself can gain in biomass productivity with anthropogenic OM additions. In such cases, reducing soil quality to biomass quantities leads to misinterpret above-ground vegetation change for soil degradation.

Second, the emphasis on biomass production, rather than or in addition to quality, stability, or composition, suggests evaluative criteria other than ecological. That is, it points to the capitalist fixation with producing ever greater amounts of commodities. A red pine plantation replaced by an agro-diverse cropping system results in less total biomass but greater biomass diversity. A narrow quantitative focus misses this difference altogether. Moreover, given the wider capitalist context of soil science speak, it is clear that higher biomass systems that are important for, say, subsistence gathering purposes would be lesser valued than less biomass producing market-oriented plantations or cropland. This is implicit in concerns raised about taking care to distinguish primary production (e.g., biomass) from crop prices (e.g., Blaschke, Trustrum, and Hicks 2000, 23), which suggests a confusion of ecological and social processes reigning among scientists.

These confusions are exacerbated by assuming that only people can degrade soils or by equating human impact with disturbance, a commonplace that flies in the face of evidence at times put forward by the same scientists making such pronouncements (e.g., Blum

1998a, 4; Lal 1997; Lal et al. 2004, 4–5, 18). Those that see people (and presumably themselves) as capable of constructive relations with soils leave the rest of nature off the hook, but still regard only people as capable of degrading soils (e.g., Gerrard 2000, 180). There is no possibility, in a presumed harmonious human-free world, of soils being negatively affected by the combined action of wind and water during arid climate phases, of soil-scouring glacial advances and retreats, of soils-submerging sea-level rise, of soil- liquefying earthquakes, or of soil-exploding asteroid impacts (Certini and Scalenghe 2006, 207–208; Dobrovol'skii et al. 2003; Schaetzl and Anderson 2005, 342–346). The same false dichotomy found in pedogenesis theories (Chapter 2) is replicated here, where nature, external to people, cannot feature any soil degradation.

The Main Ideological Underpinnings of Current Soil Degradation Discourse

Soil degradation has been defined differently over time and its conceptualization varies moderately according to specialist, with ample convergence on several themes. As in the case of soil quality, it is not possible, without specific reference to a social context, to state that a soil is getting degraded. It depends on what a soil is deemed useful for and by whom, who is affected by changes in soils and how. In flagrant contradiction with evidence, soils are expected to remain stable (or not degraded, by definition) without human impact. Some scientists regard only people as capable of degrading soils and, at other times, other forces are admitted into the soil degradation arena. This inconsistency reflects a prevailing society-nature dichotomy (or, better, an ideology of universal and external nature, as Neil Smith identified it), where people are unnatural and sometimes viewed as hopelessly degrading of soils, while "nature" is supposed to remain stable to suit some vaguely defined use.

Moreover, behind lofty universalizing concepts (e.g., ecological functions, soil energy or resilience) lie assumptions not only about usefulness, but, when one scratches the discursive surface, also of market-oriented use and production. Soil scientists largely deem soils as good only if they can help generate more stuff, whether crops or a more generic biomass. Experts seem unaware of the possibility that what counts as a functioning or productive ecosystem can vary, dare one be so bold, according to social context. When seen in a context where "economy" stands for capitalism, this is hardly a departure from the destructive maximum-yield approach that soil quality assessment was supposed to restrain, if not critique.[1] It is anyway tempting to be amused by the near-fetishistic labelling of soils as more or less productive. Soils, in themselves, produce nothing; they are products of interactions. Even so, productivity potential depends on technological system (and therefore social relations), not just soil characteristics (Pieri 1992, 16). Soil scientists, by fixating on service, quality, monetary value (Chapter 2), and productivity, project capitalist economies onto soils, contradicting otherwise genuine concerns over the fate of soils.[2] The durability of these biases is striking, as they are virtually the same as those identified in Blaikie (1985, 22). To regard the problem as one of a lack of a clear definition (e.g., Dobrovol'skii et al. 2003) is much too generous and misses the point. The problem is simply the tacit acceptance of capitalist ideologies, resulting in a lack of relational logic and in internally inconsistent approaches.

THE EXTENT AND SEVERITY OF SOIL DEGRADATION

The above-described approaches permeate assessments regarding the extent and severity of soil degradation, but there are additional obstacles to grasping the overall situation of soils worldwide that result from systemic and historically cumulative social inequalities. To put the matter simply, current understanding on the global reach and magnitude of soil degradation is poor. This reflects the level of importance given by institutions with the economic power to fund the necessary basic research, a low priority reproduced both by environmentalist and leftist movements, where soils hardly figure at all among environmental concerns, and by the scientific mainstream, as shown by the treatment of soils as afterthought in the *Millennium Ecosystem Assessment* (see Hassan, Scholes, and Ash 2005).[3]

Data Availability on Soils

One aspect of basic research is investigating soil characteristics at different points in time to determine how soils are changing. Soil surveys can be used for such purposes, but they have seldom been concerned with degradation until the 1930s and then primarily with erosion. Stored samples, long-term field-experiment records, case studies, and other historical sources can also enable such assessment (Baranyai, Fekete, and Kovács 1987; De Clerck, Singer, and Lindert 2003; Lindert 2000; Markewitz and Richter 2001; Montgomery 2007b). The trouble is that only for a few places are there soil surveys older than a few decades (if there are surveys at all) and archived samples and historical records tend to be similarly rare. Long-term experimental stations are also geographically limited and represent a narrow range of situations, largely humid temperate environments. Surveys, using different classification systems, have also been confined to administrative borders in select countries, hindering the analysis of processes that are in actuality largely contiguous and beyond such borders. Hence, soil surveys and other sources remain highly differentiated in their data quality, availability, coverage, and scope. The most extensive and detailed databases tend to be from countries with high economic and military leverage. Most of the rest of the world is comparatively very ill served still.

Adding to challenges in obtaining adequate information is the fact that until the 1960s, there was little concerted effort at a global soils assessment. The first world soils map, accomplished largely under the auspices of the FAO, did not appear until 1971. It had many problems, with mapping units based on information that may or may not exist or may pertain only to a small fraction of the area represented. Since the early 1990s, the map has been updated with standardized data from existing national surveys through the International Soil Reference and Information Centre (ISRIC) and the International Institute for Applied Systems Analysis (IIASA).[4] The result is the 2008 Harmonized World Soil Database (HWSD), which is highly uneven in data quality but is becoming the basis of land use policy evaluation (FAO et al. 2012). The soil parameters include organic carbon, pH, water-holding capacity, soil depth, CEC, clay percentages, total exchangeable nutrients (a proxy for plant availability), lime and gypsum contents, sodicity, salinity, texture, and granulometry. Reliability problems nevertheless persist, the magnitude varying according to regional coverage (Batjes 2002). The cropping system productivity focus notwithstanding (Batjes et al. 1997), the data can be put to multiple uses, including other forms of food procurement. However, there is much information that is missing because of data scarcity (e.g., bulk density, exchangeable aluminum, and soil organism diversity), while some data have been excluded because they do not conform to USDA standards (standards selected without justification), such as systems that use different particle size classes. Much caution must therefore be exercised when using the HWSD for soil degradation estimates.

Global Assessments of Soil Degradation (GLASOD)

The first attempt at a comprehensive and global evaluation of soil degradation was quite recent. Initiated in 1974, under the FAO and UNEP, a monumental project called the Global Assessment of Soil Degradation (GLASOD) was completed in 1990, using the FAO world soils map database. The result was the publication of a 1:10,000,000 scale map, with an accompanying report and database. The study pointed to a rise, between the 1940s and 1980s, from roughly 10 percent to 40 percent of total global farmland ruined by soil degradation, excluding land under shifting cultivation.[5] Such an alarming figure was ostensibly aimed at convincing government action, to help identify priority areas, as well as provide a preliminary database approachable to non-experts (Oldeman, Hakkeling, and Sombroek 1990).

GLASOD was supposed to be only a first step in view of plans for more precise and extensive data gathering over the following decades. Instead, the figures have been used liberally to support claims about the gravity and distribution of soil degradation by scientists (e.g., Bot, Nachtergaele, and Young 2000, 27–28; Fullen and Catt 2004, 2; Gerrard 2000, 180–181; Hassan, Scholes, and Ash 2005; Lal 1998; Oldeman 1994; Steiner 1996), by environmental organizations like the World Resources Institute (e.g., WRI 1999), and by some prominent environmentalists (e.g., Brown 2003). Consequently, GLASOD has been infused with authoritative pomp, irrespective of problems admitted by the authors. Salient among them are the inappropriateness for "national scale" maps, mapping exaggeration of degradation extent (a basic map unit area with only 1 percent degradation is visualized as 100 percent degraded), inconsistencies due to differences among "experts" reporting, unverifiable local soil scientists' judgment, paucity of actual measurements, visual exaggeration of the geographical extent of degradation, stressing only destructive impact by humans, and frequent use of unreliable equation-derived estimates (Eswaran, Lal, and Reich 2001; Lal et al. 2004, 28; Lindert 2000; Nachtergaele 2004; Oldeman 1994; Rozanov, Targulian, and Orlov 1990, 203; Safriel 2007).[6]

Somewhat uncharitably, GLASOD is now decreed "a map of perceptions on the type and degree of degradation" that is "now out-of-date,"[7] but the flaws are much deeper.[8] There is no discussion about how to treat instances involving multiple forms of degradation over the same area, visually or analytically, such as wind erosion combined with pollution (see also Van Lynden 1995, 14). Diverse forms of soil degradation are instead represented as if they could be separable one from the other. But even if one were to make the case that an area is predominantly affected by water erosion, there should be qualification as to whether and how the process affects and/or is affected by or combines with other changes in soil properties. Soil erosion, for example, may occur as a result of accelerated decomposition rates of OM and/or prolonged drought or rainfall combined with particular texture characteristics (cf. Bai et al. 2012, 7). Cartographical representation is also much more problematic than the GLASOD authors recognize. Soil mapping units are delineated on the basis of "physiography," defined in terms of relative homogeneity in topography, climate, soils, vegetation, and land use (Oldeman, Hakkeling, and Sombroek 1990, 8–9). Because the mapping units devised range over tens of thousands of hectares, the claim for relative homogeneity within the mapping units is dubious and the data therefore so generalized as to be as useful as aesthetically pleasing drapery in analyzing soil degradation. Then there is the funny logical slippage where land use becomes a physiographic feature, turning soil degradation into the lay of the land and soil scientists into victims of their own abstractions. Such confusion of biophysical and political categories is not uncommon. Webster (1997), in a discussion on methods of evaluation and inventory that can effectively capture soil variability, advocates for an approach that starts from the field, proceeds to the farm or estate, thence to physiographic region, the nation-state, and finally the world. The switch between social relations of power and biophysical processes is as seamless as it is insidious. The political struggles producing fields, farms/estates, and nation-states become exogenous nonhuman phenomena.

Soil Degradation as Commercial Crop Yield Decline

Official recognition of major problems has had some institutional reverberations and further work has been promoted to improve matters.[9] The FAO has established the Global Soil Partnership in 2012 and the Intergovernmental Technical Panel on Soils (set up in June 2013).[10] This might be welcome news to dirt enthusiasts like me, but in capitalism what seems like a gain for humanity often turns out to be a major setback for the many. Formal intensification of international support for worldwide soil degradation monitoring has been inversely proportional to overall funding. The result of reduced funding is reflected in the fact that an updated version of worldwide figures has not come about except piecemeal. Worse, soil degradation estimates have been subsumed under different projects, sometimes hardly related to soils at all, folded under land degradation or ecosystem services databases (Omuto, Nachtergaele, and Rojas 2013).

A geographically circumscribed UNEP-FAO project called Land Degradation Assessment in Drylands (LADA), funded by the Global

Environmental Facility (GEF), involved pilot studies in six countries carried out between 2006 and 2011. It aimed to establish baseline information and methodological guidelines. It supposedly incorporates input from "local stakeholders" and the outcomes of constructive human impacts, but it involves no actual people using soils (e.g., peasant cultivators) and only marginally addresses soil degradation.

This is to say the least a peculiar development, given the outcomes of antecedent projects, such as the People, Land Management, and Environmental Change (PLEC) project. The project was carried out under the United Nations University over six largely non-industrialized areas between 1992 and 2002 and funded by the GEF during the final six years. It was a farmer-centered participatory approach to land degradation that led to identifying knowledge and technologies that sustain agrodiversity and reduce destructive impact (Tengberg and Batta Torheim 2007). Apparently, findings from the bottom-up are best ignored if the purpose is to reach the powerful (e.g., "policy-makers").

Rather than learning from studies emerging from projects like PLEC, a new Global Assessment of Land Degradation and Improvement (GLADA) was introduced that promised "to identify (1) the status and trends of land degradation, (2) hotspots suffering extreme constraints or at severe risk and, also, areas where degradation has been arrested or reversed."[11] But the focus was on "biomass" (i.e., crop) production, conflated with land degradation (Bai et al. 2012). The enterprise rests on remotely sensed reflectivity data that are compared to a crop-production model to evaluate trends in "land degradation." The model, however, is about rain-fed crops (and it is not clear what is included as "crops"), not ecosystems or soils, and the objective is to determine whether any drops in crop yield is due to soil degradation in contrast to weather, assuming optimum nutrient availability, no pathogens, and no change in soil or crop characteristics. In other words, major factors influencing crop production are simply tossed aside. More importantly, soils are reduced to inputs of texture, depth, and water-holding capacity. As a consequence, soils slip out of view, except as vehicles for crop yield. The subsequent report (Conijn et al. 2013) makes for even more confused estimates, as soil and land are used interchangeably and crop yield is still assumed to be a function of weather patterns and a handful of soil physical properties. It appears that GLADA represents very well what is gained when doing research on the cheap. No attempt is made to identify the extent or severity of soil degradation. Unfortunately, the only critique of this exercise, coming even from the promoters of the approach, has so far been what should have been evident from the beginning, which is that NDVI-based data on "greenness" cannot serve as proxy for other variables (Bai et al. 2008; Kellner, Risoli, and Metz 2011; Nachtergaele et al. 2011, 8).

After discovering the obvious, LADA and GLADA have been, in turn, superseded by another FAO-UNEP-GEF joint project titled Global Land Degradation Information System (GLADIS), which features a searchable online database with roughly the same limitations regarding regional data availability and problems of regionally specific differential data resolution as previous databases (another way of saying that no funding was made available to carry out actual fieldwork). The project proceeds from the above-critiqued ecosystem services approach, but assesses services on the basis of biomass, soil health, water resources, biodiversity, economic production, and social and cultural wealth (Nachtergaele et al. 2011, 14–15). This time, possibly as a result of learning from the misuse of GLASOD, there is an explicit warning[12] against use of GLADIS for national policy. This is despite the stated objective of the project's "deployment as an interactive resource to inform decision-making on global level actions,"[13] as if global actions had no repercussions on national policy formation. There is then the matter of ecosystems and people's relationship to them. Given the topic at hand, let us look into how soils enter the stage. Soil health is deemed of relevance only for farming systems (shifting cultivation and gathering-hunting are excluded entirely), which are understood as economically productive only if they exhibit high output. That seems congruent with the scientists' construct of the human subject, "the beneficiary," whose ecosystem service preferences change over time and who, as the generic beneficiary, performs the superhuman feat of living in all societies and none at the same time. Yet this ecosystem service beneficiary has some definite characteristics, identifiable in the services ecosystems provide for economic benefit, defined as getting the highest output from the land, and social and cultural wealth, fulfilled by "[market] accessibility, tourism and the presence of protected areas" (Nachtergaele, Biancalani, and Petri 2011; Nachtergaele, Petri, and Biancalani 2010). Apparently, everyone wants to and can overproduce, sell stuff, be a tourist, and let nature be, all at the same time. In this fabulous world where capitalists' contradictory and rapacious objectives are made to be everyone's dream future, we are all the same and scales of action are easily kept apart, since we all have the same political leverage. We are in a happy world of concerted interactions among equals aiming to combat land degradation together, in harmony. In this, even alternatives like PLEC are of little help, since they avoid confronting problems that might blow away the much desired synergy between agriculture and environmental protection (Tengberg and Batta Torheim 2007, 271–273).

Ultimately, the problems encountered in all these assessments are not just technical, but foundational. One is an inbuilt bias toward the ruling classes and their allied technocrats. The reliance on "experts" (that is, soil and/or environmental scientists), the often gratuitous inclusion of population density figures in global soil degradation estimates (rather than relative intensity of actual, measured impact), and the preoccupation with providing accurate data that suits the national state, all make the exercise politically palatable to those whose interest it is to mask capitalist relations of domination through smoke screens. Regrettably, this assumed legitimacy of devoting scientific attention to fulfil the demands of government officials ("planners," "policy-makers," "decision-makers"), who are largely at the service of capital, is widespread and little contested among soil scientists and associated specialists (cf. Bai et al. 2008; Oldeman, Hakkeling, and Sombroek 1990, 3–4; Sonneveld and Dent 2009).

Another set of problems can be directly linked to the ways in which soil degradation is constructed, as discussed above. GLASOD was ostensibly guided with the understanding developed in 1979 at UNESCO that occurrences of soil degradation are "human induced phenomena which lower the current and/or future capacity of the soil to support human life,"[14] but the emphasis has actually been on farming "productivity" (Oldeman and van Lynden 1996, 2, 9). With this sleight of hand, crop yield decline is conflated with degradation, even if factors other than soil degradation might be more influential. GLADA is rendering explicit what was ensconced in GLASOD while at the same time moving away from assessing soil degradation per se. GLADIS is the final parody, with soils reduced to how well they can boost output. Thus, market-oriented views of farm productivity (e.g., shifting cultivation and non-agricultural uses are excluded) find their way into the practice of adjudicating which areas of the world are deemed degraded and in need of intervention. Because soil degradation is systematically reduced to and mapped according to human impact and the demands of largely market-oriented farming, it is not possible to discern nonhuman sources of degradation or to distinguish ecologically sustainable from destructive forms of land use that are excluded from analysis.

The contradictory bourgeois view of nature also emerges in such global assessments, carrying forth a view, expressed directly in the above-cited UNESCO document, that soil degradation is solely human induced. Accordingly, soil-stabilizing land use is not factored into the GLASOD inventory, which summarily precludes any evaluation of the net effect of human impact (Brookfield 2001, 174) and denies a role to nonhuman forces. A nature-society dichotomy is evident in more recent versions as well. It is difficult to incorporate, for example, Technosols as "nature" providing ecosystem services when it is the actions of people in the past and/or present that have brought about such potential "services." Such processes are made unintelligible. Relative to assessing soil degradation, recent global assessments are even less helpful than GLASOD, as they have subordinated soil assessments more explicitly under capitalist crop yield prerogatives. It becomes increasingly difficult to disentangle actual soil degradation processes from those of other "land" or "ecosystem service" variables or from scores superimposed through productivity expectations in GLADA or GLADIS databases. It appears that HWSD remains a more reliable option, with all the above-described limitations and biases.

THE PROBLEMS OF AND WITH ACCELERATED SOIL EROSION

Such major failings in global assessments should temper claims about worldwide accelerated soil erosion. Thanks to the painstaking work of hundreds of scientists over many decades, much is known about the mechanisms involved and its widespread occurrence. But the evidence about its extent and severity is highly disputable. The claims are also helped little by a history of soil conservation failures due to technocratically formulated and imposed policies insensitive to both people using soils for their livelihood and contrary evidence (Brookfield 2001; Ellis and Mellor 1995, 250; Hudson and Cheatle 1993; Roose 1996; Safriel 2007, 23; Stocking and Murnaghan 2000; Zimmerer 1993). As in the case of "desertification" (Tengberg and Batta Torheim 2007; Swift 1996), agricultural and environmental policies as well as environmentalist arguments have been built around this subject, at least since the 1920s, with a major resurgence in the 1970s and attempts to resuscitate alarm over the past few years (Bennett 1939; Brown 2010; Brown and Wolf 1984; Carter and Dale 1974; Eckholm 1976; Hyams 1952; Jacks and Whyte 1939; Mitchell 1946; Montgomery 2008; Osborn 1948; Sears 1935; Vogt 1948). The treatment of erosion as separable from other types of soil degradation, historical insensitivity to variable and shifting combinations of ecological and social processes, disproportionate attention to accelerated erosion at the expense of more pernicious forms of soil degradation (e.g., acid-sulfate soil activation), and major methodological and analytical flaws in soil erosion research all obscure from public view the social basis and political content of soil degradation research. Instead of confronting and attempting to resolve these problems, prominent environmentalists (e.g., Brown 2010; Leahy 2008; WorldWatch Institute[15]; World Wildlife Fund[16]) and academics (e.g., Montgomery 2007b; Pimentel 2006; Wild 2003, 70) continue to disconnect soil erosion from social context and to treat it as if a straightforward arithmetical matter. The soil erosion emphasis also enjoys wide institutional backing. The European Commission's Join Research Centre places soil erosion at the top of the list of its identified threats to soils,[17] while the FAO's Land Degradation Assessment and the USDA (2011) report on soil resources includes erosion, but no other form of soil degradation.[18]

Global assessments are particularly deceptive. Based on a compartmentalized view of soil properties, degradational forms are mapped as unrelated or independently occurring. Their respective geographical distribution is then used to make comparisons according to total estimated area affected. Different types of soil degradation are thus ranked and thereby accelerated erosion attains primacy of concern, regardless of the dubious nature of what is being compared. Accelerated erosion could occur or increase in severity because of chemical and/or biological property degradation and/or changes in environmental erosivity factors. For example, there could be a decline in OM (biochemical properties) due to changes in cropping system or acidification (chemical properties) could occur through long-term urea fertilizer application. Either OM depletion or acidification can lead to reduction in plant cover and greater soil erodibility. There can also be cases in which wind and water erosivity increase over time (e.g., regional climate change) and raise erosion rates without appreciable changes in erodibility factors (e.g., levels of OM). When accelerated erosion is mapped without making such linkages explicit, it is unclear whether the areas affected by accelerated erosion are cases of physical, biological, and/or chemical varieties of degradation. There is often an overlap in the forms of soil degradation, making any neat separation of degradation categories suspect and creating potential for false comparisons. Therefore, ranking soil degradation types according to total estimated area affected (e.g., GLASOD) risks exaggerating some problems at the expense of others or misidentifying the soil degradation problem altogether. If a problem is low pH and heavy metals toxicity leading to sparse vegetation and increasing erosion rates, it would make little sense to try to fix the problem through afforestation without liming.

There is also often a tendentious framing of the problem by way of partial accounting and dubious assumptions regarding erosion and deposition processes. Typically, the soil erosion story begins with the painstakingly slothful pace of breakdown of rocks and minerals that is necessary to form soils (Lal 1990, 3). This commonly held view erases the soil-forming process of mineral and organic material additions (Chapter 2). One must studiously ignore the large amounts and movements of available sediment (e.g., dust from beach and desert dunes, floodplain deposits, material from eroding soils themselves) to be able to claim that only rock weathering is involved in making soils (Blum, Warkentin, and Frossard 2006; Douglass and Bockheim 2006; Muhs et al. 2010; Simonson 1995; Yaalon 1987). Since soils form out of both breakdown and deposition of materials, it is deceptive to pit erosion rates against rates of weathering (e.g., Hillel 2008, 3; Montgomery 2007a, 13–14), especially when soil erosion can contribute to forming other soils. The pedogenic outcomes of moving soil and sediment need not be exaggerated, however. Typically, dislodged particles do not travel far from the source, although they may enrich soils downslope temporarily (until the next erosive event), and dust deposition usually contributes marginal amounts of fresh material within human life spans (Boardman 2006; Verheijen et al. 2009).

Weathering and accumulation processes may nevertheless be much faster than imagined, as recent research demonstrates, and it could even be argued human impact may cause accelerated soil formation, as in the case of farming-induced mudstone and shale weathering in Sichuan Basin, China (Wei et al. 2006). Rates of 5–10 mm per year of soil formation (15–20 cm of soil thickness over less than 30 years) were observed in the Ouachita Mountains, US, resulting from bedrock exposure by way of dam spillway construction (Phillips, Turkington, and Marion 2008). This may vindicate Brookfield (2001, 90), who observes that "the rapidity of topsoil formation has not yet been fully recognized by those who write doom-filled scenarios about soil erosion." However, Stockman et al. (2010) found much slower weathering rates of about 0.010 mm per year in Werrikimbe National Park, Australia, which are found to be typical of the region. Dust deposition has only recently been taken into account, but studies of deposited particles influx into various parts of Southern Europe, mainly from the Sahara Desert (Mulitza et al. 2010), indicate a range of 0.0002–0.03 mm per year (0.002–0.39 t ha^{-1}), which, combined with weathering rates, give a range of soil production of

0.031–0.108 mm per year (0.4–1.4 t ha^{-1}) (Verheijen et al. 2009, 28–29).[19] Soil formation rates are highly variable and tend to be faster at the beginning, slowing down as soils become deeper. Presumably, dust deposition becomes more important in older soils, but in some cases one should factor in anthropogenic deposits, which can be considerable but are under-researched (e.g., large earth movements in ancient sites like Cahokia or machine-aided sediment movement through mining and construction). Aside from these aspects, data on soil formation is unavailable for many regions and they reflect a variety of time periods, from hundreds of thousands of years ago to the last few decades.

Accelerated soil erosion can still be conceivably compared to known soil formation rates, but one must be very careful when doing such analyses. Montgomery (2007b) has been one of the few scholars compiling existing studies to construct overall assessments of global net erosion rates, although concentrating on farming alone and only on water driven erosion. He concludes that conventional farming has been the most effective erosive agent, outstripping soil formation by ten to 100 times. Many forms of "conservation agriculture" and even no-till industrialized agriculture (only about 5 percent of global cropland is managed with no-till techniques) are in the range of geological rates of soil erosion, but still exceed rates of erosion under native vegetation. Verheijen et al. (2009), putting together many studies on agriculturally induced erosion from different parts of Europe, similarly find that soil loss rates reach about 0.231–3.08 mm a^{-1} (3–40 t ha^{-1} a^{-1}). These put the figures to twice to 100 times soil formation rates. The overall aim of these researchers is, among other things, to show that current mainstream farming techniques have to be changed to achieve sustainable land use and that the rates of erosion currently acceptable at institutional levels, the T variable ("soil loss tolerance"), are too high (the T factor is one variable in the not so "universal soil loss equation," see Blaikie 1985).

This may indeed be too high, but assigning an absolute global figure to acceptable soil loss rates, in a bewildering array of diverse contexts, is to court disaster. In the first instance, an absolute T value is insensitive to soil type and cropping system. As Stocking remarks:

> One centimetre of erosion may cause yields to crash on a very susceptible soil (a Luvisol, for example) yet have little effect on a well-drained, high fertility clay (a Nitosol), and may even cause yields to increase on another soil (e.g. a duplex soil with greater exposure of clays with better water capacity).
>
> (Stocking 1996, 149)

This is borne out by many studies showing differential effects for similar rates of erosion depending on crops grown and soil type (Lal 1990, 1995; Langdale and Shrader 1982; Tengberg, Stocking, and Dechen 1997). There also may occur, at times, downslope and lateral soil nutrient enrichment resulting from soil erosion (Quinton et al. 2010; Verheijen et al. 2009, 30), depending on the eroded material's content.[20] Accelerated soil erosion also does not necessarily result in crop failure, as often assumed. There are many factors involved, such as changes in soil chemical and biological properties, weather patterns, and inter-species relations (e.g., rising pathogen populations), among other environmental variables (Nachtergaele 2004). If one takes into consideration multiple possible uses for the same soil besides domesticated crop cultivation, then the political repercussions of soil erosion discourse come to even fuller view, especially when mainstream (i.e., money-generating) cropping systems are overwhelmingly assumed as subjects worthy of soil erosion research. Entire people's life-ways are thereby summarily dismissed.

Closer inspection of existing soil erosion data reveals that the results, including comparative studies of areas under native vegetation and cultivation, are largely derived from small plot experiments, sediment yield measurements, and lake sediment analyses, all of which are notoriously unreliable sources, at least for decadal time scales. Global assessments of soil erosion in any case presume the sort of data availability that is restricted to very few areas of the world. One could still work with the many existing empirical and/or estimation models, including the Revised Universal Soil Loss Equation,[21] to derive total net erosion rates and test them against measurements in different physical environments, provided methodologies are sufficiently encompassing and comparable (Boardman 2006; Merritt, Letcher, and Jakeman 2003; Renard et al. 1996). However, such models cannot account for wind erosion, nor the wide-ranging fates of eroded material (Stocking 1996) and the spatially and temporally variable connectivity and distribution of erosivity and erodibility factors (Weltz, Kidwell, and Fox 1998). Summing the measured or estimated figures cannot therefore yield reliable information about net losses beyond at most a small area.

Verheijen et al. readily admit and summarize the well-known problems with such data, but Montgomery is regrettably not as forthcoming. The major problems with such estimation techniques and field measurements cannot be assumed to represent the outcomes of land use, especially when it is diverse and shifting. When eroded soil material lodged at short distance from the source area is counted as part of total soil loss, overestimation ensues. Relying on fluvial sediment load to gauge soil erosion is even worse. The sediment comes from the entire river catchment, not just areas directly used by people. Fluvial sediment load figures also give undifferentiated total losses from many different places in the river catchment (the total area covered by a river and its tributaries). Soil particles detached by water or wind can settle at some points in a landscape for a while and then be moved again, eventually, perhaps, reaching a river. The sediment derived from soil erosion in fact may not even reach a stream. It may get stuck along the way, depending on the geometry of the slope (if the slope is initially steep and then grades slightly upwards, for example). Then it may linger for enough time to lay the basis for the formation of a new soil, unless erosive forces are strong enough to dislodge them again. River sediment information also does not evince which soils have been thinned within the catchment and by how much. The volume of sediment in a river does not represent the volume of topsoil lost, nor does it help indicate the location of eroded soils (Beach 1994; Boardman 2006; Forsyth 2003, 29–32; Lal 1990, 190–191; Reij, Scoones, and Toulmin 1996, 1–4; Stocking 1987, 1996; Trimble and Crosson 2000; Zimmerer 1994).

There are yet other problems with global or continent-scale estimates derived from compilation of case studies from small areas or sediment movement in rivers. Montgomery's approach is particularly faulty. He asserts that cultivation largely magnifies erosion rates to those of alpine slope levels, which contradicts his findings that posit conservation techniques almost on a par with both geological and native vegetation erosion rates. In fact, were one to follow Montgomery's numbers to their logical conclusion, people should give up farming altogether. Moreover, he fails to explain why native vegetation erosion rates are sometimes lower and sometimes higher than geological rates in his figures. His assumption that soil depth must result from a balance between production and erosion rates would also preclude the possibility of soils ever disappearing, which should be considered absurd. Given that soil formation occurs through both weathering and material additions over time, the overall soil erosion process cannot be discerned by restricting the sample of available studies to past soils that are presumed dynamically stable. The research must include studies of sediments and their distribution over time. In other words, the study does not address the origins of the material that led to soil formation. The author fails to consider and discuss what happens to sediment derived from eroding soils over a geological time frame.[22] The case studies Montgomery impressively compiled, therefore, are biased against even posing this sort of question.

Comparing geological erosion rates with those related to agriculture is a dubious undertaking for several additional reasons. Farming encompasses activities and impacts that have varied tremendously over time and space and cannot be reduced to a conservation-conventional dichotomy in the present. Nor can the matter be viewed logically in terms of farmers' techniques alone. An ensuing potential for greater erosion is not due to whether farmers' techniques are of the conservation or conventional variety. The same set of cultivation techniques becomes soil preserving or destructive according to changing environmental dynamics and social arrangements, which are not necessarily correlated (Berglund 2007, 113; Brookfield 2001; Forsyth 2003, 224–225; Vandermeer, Shiva, and Perfecto 1995). What this all means is that if one focuses on cultivation techniques as the main cause (land management), it is not possible to determine whether even the same land management practices are consistently soil-conserving. Other factors must also be studied before concluding that human activities cause accelerated soil erosion.

These underlying difficulties in measuring soil erosion rates can have major political implications. They can lead and have led to implementing policies that are socially harmful. To add insult to historical injury, many soil scientists and policy-makers continue to portray especially Africa as overwhelmed by erosion. These kinds of claims, to some extent, continue a long tradition of self-serving exaggeration started by colonial authorities and scientists in the early twentieth century (Bell and Roberts 1991; Showers 2005; Swift 1977). Kiage (2013), in a critical review, shows nonhuman erosivity and erodibility factors as playing a much greater, if not, in some cases, a determining role in accelerated erosion rates in Africa. It might then be advantageous for farmers not to regard soil erosion as a priority, as it is sometimes lamented. The main concerns of most farmers is producing a good quality yield of crops, enough at least for subsistence and, in the case of commercial farming, enough yield to make a profit or just pay the bills. Often, farmers do not necessarily see a connection between soil erosion and soil fertility, even when there is one, especially because there tends to be a lag between erosion and fertility decline (Brookfield 2001) or they may already have an understanding and appreciation of the process without scientists' aid (Zimmerer 1993). What complicates matters is that erosion is not a process that necessarily leads to crop yield decline. Some forms of erosion may even be beneficial to soil fertility when soils receive nutrient additions from upslope. Great care should be taken, then, in erosion assessment, especially as they feed into policy formulations, and it would be more effective (relative to efforts against actually problematic erosion) to understand the issue in social and ecological context, rather than treating it as always necessarily negative.

Even if one were to take mainstream interpretations of erosion as entirely credible, anti-erosion measures can end up addressing only part of the presumed problem. In the US, for instance, policies have been introduced, as subsidies mainly to agribusinesses, to have farm businesses set erodible land out of production for ten years, with five-year conservation plans (Farm Act, 1985). The debt to the state is erased if erodible land or wetlands are taken out of production for 50 years. The conservation standards have been eased since 1987 and since 1996 businesses are allowed to end contracts without USDA consent (the other party to the contract). If one were to follow the concerns over soil erosion from many soil scientists and find no flaws in conventional measures, US soil erosion ($2.31\,\mathrm{mm\,a^{-1}}$ or $30\,\mathrm{t\,ha^{-1}\,a^{-1}}$) continues on average at eight times the rate of soil formation (if not more, according to Montgomery 2007b, and Cox, Hug, and Bruzelius 2011) in spite of all conservation efforts and putatively drastic erosion rates curtailment (Lal et al. 2004). It seems that there is a substantial discrepancy in the evidence presented and the interpretations of the effectiveness of policy. Yet even if policies had been effective, they would address 60 percent of the susceptible land area (FAOSTAT 2006). The remaining sources of anthropogenic erosion are not farming-related, so these scientific works, as well as conservation efforts and subsidies (mainly to wealthy farmers) ignore some key sources of erosion, like the construction of large industrial and residential sites and large scale mining operations. In light of this and the above discussion, decrying farming as the main cause of accelerated soil erosion exemplifies the limited (and socially unaware) understanding of many well-meaning scientists.

Resisting Peak Soil

Wider awareness of the trouble with soil erosion evidence is hampered by catchy “peak soil” repackaging. The new branding scheme has even found favor in some left-leaning and unabashedly leftist outlets (Ahmed 2013; Fitz 2013; Leahy 2008; Montgomery 2008). The argument, as simple as it is simplistic, is a regurgitation of what has been claimed about fossil fuels combined with what some soil scientists have been claiming for decades: that soils are eroding worldwide faster than they are formed. The new twist is to reframe the erosion problem in light of more popular concerns about climate change such that, as in the case of oil, we are approaching the global exhaustion of soils as a resource. The trouble is that consumption rates do not govern oil reserves availability as much as global political struggles over resource control, involving processes like oligopolies and futures markets. Peak oil arguments detract attention from the relations of exploitation inhering the production and consumption of oil as a commodity and from the struggles necessary to overcome the social forces imposing fossil fuel dependence in the first place (Labban 2008). Peak oil or, more recently "peak appropriation" arguments (Moore 2011b, 138) also foreclose the possibility of developing alternatives that can build on and replace fossil fuels (Schwartzman 2009, 18).

The notion of peak soil is similarly tenuous and diversionary in resting on unreliable GLASOD figures and in obfuscating the sets of exploitative relations that lead to accelerated soil erosion (Blaikie 1985). There are also crucial differences. Unlike oil, soil can be formed within human life spans, people can facilitate and speed up soil production, and soil can be used without it running out. Some of these differences have been obvious even to mainstream economists (e.g., Timmons 1979, 54), but there are other fundamental flaws. The peak soil argument does not distinguish constructive from destructive cases of accelerated erosion and it exaggerates one form of soil degradation at the expense of others, like salinization and acidification.

It is sobering to find such poor understandings of soil dynamics in leftist work. The prolific eco-Marxist sociologist Foster (1994, 23–24) explains that since "forests form soils," deforestation induces soil erosion, demonstrating an embarrassing lack of understanding. But such a remark also obscures soil-forming aspects of human impact, as when deforested slopes are terraced. Implicitly denying this has the unfortunate effect of converging with technocrats on matters of causation, according to which people tend mostly to contribute to soil destruction. The lack of appreciation for human-induced pedogenesis or for constructive contribution towards soil formation is much more evident in other leftist writings (Mazoyer and Roudart 2006, 55–60).

Equally uninformed, Klare (2013, 186, 194–195), a contributor to the U.S. center-left weekly *The Nation*, constructs a scenario of dwindling soil resources coveted and in the process of being taken over by large firms and powerful governments, in a race to grab all the natural resources left. Aside from, among other problems, the tenuous empirical basis for his argument as well as the erasure of social movements and struggles (only corporations and governments exist in Klare's world), Klare also falls for the peak-soil antics (and populationism) of Brown (2003), leading Klare to the conclusion that capitalists and governments are craving cropland that is disappearing everywhere due to accelerated erosion. It is difficult to believe that corporations or governments would be primarily motivated by assertions about global soil erosion (other forms of soil degradation being apparently irrelevant) and population growth, rather than, say, competition over profits.

Ultimately, soil erosion, as soil degradation generally, should be a matter of finding out the politics of land access and use in relation to wider processes, which can reveal why people are using soils in certain ways (Stocking and Murnaghan 2000). On that basis, the rate of soil erosion can be more meaningfully determined as accelerated or not relative to local conditions. Peak soil and other such arguments deny the possibility of officially unrecognized soil experts (e.g., peasants) participating in determining whether and to what degree a soil degradation problem exists. They are the sort of simplistic generalizations that may find easy purchase towards political mobilization, but are as reactionary as technocratic and colonial interventions. One need not, in contrast, develop paranoid delusions about soil erosion as a government centralization ploy, as neoliberal capitalist ideologues like Lindert (2000, 243) insinuate. Calling for soil scientists to find "a consensus on mean rates of soil formation and soil erosion" in the face of a dearth of information (Verheijen et al. 2009, 27) can only fan the flames of skeptics who see scientists and governments conspiring to ruin the welfare of the small capitalist family farmer, an entity that at this point is largely imaginary (see Goodman and Redclift 1989).

In spite of all the diversions and technical difficulties, there actually is sufficient evidence for accelerated soil erosion and its connection to declining plant life and biodiversity in various parts of the world (e.g., Boardman 2013; Montgomery 2007b; Stocking 2003). A lack of worldwide monitoring and poor global assessment, as well as misuse of existing evidence, does not support any single view about the extent and magnitude of the problem. If anything, it should make people clamor for more research in more places. Known or experiment-based accelerated soil erosion disasters (Boardman 2006; Tengberg, Stocking, and Dechen 1997) should stimulate more concern, not baseless generalizations about what may be happening more broadly. Instead of waiting until there are enough numerical data and analyses before elaborating policies of soil conservation, it would be more reasonable to learn from existing conservation practices and to facilitate their strengthening or diffusion in tune with ecosystems and social context.

There are, after all, not a few examples of what happens when one waits until sufficient data are gathered and analyzed for quantitative trends. For example, the effects of greenhouse gases, chlorofluorocarbons, sulfate and nitrous oxide emissions on the atmosphere and on various ecosystems were known long before it became clear they would be regional or global in reach. There is already enough knowledge about human impact on soils (primarily through case studies) that one need not wait until a thorough global database is available before dealing with the problem, by which time it would be too late. Complaints about the costs of and resistance to monitoring and conservation policy implementation need to be considered in a context of class struggles, rather than taken at face value (Bone et al. 2012), and any prospect of monitoring from below, as promising as it can be for democratizing scientific knowledge production, must be carefully weighed against the possibility of its degeneration into an often gendered and racialized socialization of damage resulting from environmental impacts associated with profits for the few (e.g., Carney 1991; Schroeder 1999).

AN ALTERNATIVE WAY OF APPROACHING SOIL DEGRADATION

One strategy to circumvent currently unreliable and market-ideology influenced global, regional, and other such assessments is to follow the likes of Montgomery (2007b) and Verheijen et al. (2009) in compiling data from existing publications or to use archival information to reconstruct historical changes in soil characteristics in specific areas of the world. This could give a sense of greater accuracy, but doing so will not address the underlying presuppositions behind the process of identifying soils as degraded, presuppositions that are helpful neither in the interpretation of soil dynamics nor in identifying actual cases of soil degradation. A modified version of Blaikie and Brookfield's Net Degradation model[23] would already be an improvement because it includes both human and nonhuman impacts, either negative or positive (Blaikie and Brookfield 1987, 7; Brookfield 2001, 174). Combining that model with that of soil resilience offered by Lal (1994, 44)[24] could improve matters, as it is more specific and takes into account processes unrelated to human impact (but inexplicably excludes, unlike Brookfield's model, constructive human impact within the same ecosystem). However, both types of model fail to account for social context. Blaikie and Brookfield (1987, 4) themselves recognize this when they regard degradation as a conjuncture-dependent "perceptual term." No existing model contextualizes the consequences or wider meaning of degradation according to both ecological and social context. Depending on circumstances, the same type of impact may be degrading in one context and enhancing in another.

One could then draw from Hynes' (1993, 44–46) insightful feminist critique and agency-focused reformulation of the human impact formula.[25] A soil degradation equation could be made similarly contingent by, for example, qualifying net degradation according to local social needs. For instance, high net degradation involving upslope erosion can be a positive figure for downslope farming communities. But then one would also have to address existing and shifting contestation over what is regarded as priority within and/or between communities, including within households. Inevitably, the issue would be about how land use decisions are made and the power relations at multiple scales that affect land use outcomes. This implies being forthcoming about one's political commitments and taking great care to examine local power relations in relation to one's social position. Consequently, other steps are needed to make soil assessments relevant to actual conditions.

A first step is to recognize soil degradation as both an ecological and political question. This means that a soils expert must become aware not only of the various processes inherent to soil dynamics, but also of the social context in which soils are used (and in the process, of one's own social context and how it influences one's understanding of soils). It also entails being forthcoming about political commitments and convictions relative to the people who derive direct sustenance from using soils and to the social context at large. Most scientists studying the issue are in one way or another in agreement with the currently prevailing capitalist arrangements, at least tacitly. Their task then is to understand the ramifications of their political stance and to study how it relates to their understanding of soils and what they regard as proper use of soils. By doing this, they might find that reducing soils to production units for some market is not exactly the most appropriate route to soil preservation, even as they might not realize the connections between profit making and the exploitation, health debilitation, and even mass murder involved in the course of regular business, whether in the home, the field, the factory, the office, the prison, or the warzone. If one's political persuasion is leftist, the task might instead be evaluating competing uses (and one's own preconceptions) relative to actually existing soil properties and promoting non-capitalist uses of soils, while at the same time being careful to avoid supporting oppressive relations of power compatible with ecologically constructive impacts on soils, such as patriarchal arrangements (Bradley 1983; Engel-Di Mauro 1999; Leach and Fairhead 1995; Reij, Scoones, and Toulmin 1996).

A second step is to seek information and analyze data not only about soils, their historical development, inherent properties, and current state, but also about different or convergent local soil uses, understandings of soils, and relations of power (e.g., economic interests, political struggles within and between households, formal institutions). This latter aspect involves necessarily finding out about local social processes, being mindful of relations of domination when inquiring among local inhabitants or neighbors. This step necessarily means getting information on how local social dynamics are affected by linkages to places sometimes very far away. This is a more difficult task than field and laboratory analyses of soils, but it is necessary to gain an overview of contrasting perspectives and impacts on soils. This way of proceeding assists in arriving at an understanding of the status of a soil relative to various social positions and to one's own.

In a leftist-oriented soil quality assessment, there can be no definitive characterization of a soil as degraded. This in itself precludes much of the technocratic pretense of detached objectivity and of the bureaucratization of assessment procedures because such an approach to soil degradation demands interaction between soils experts and soil-using communities and the combination of different forms of soils knowledge. The process, being iterative, is mutually constitutive. A scientist's view and everyday analytical practices will necessarily have to change alongside the practices and views of soils users. A soil is to be regarded as degraded insofar as physiological needs and context-specific objectives are hampered by a change in soil characteristics. This requires specifying whose physiological needs and objectives are being hampered and when. On this basis, much more realistic pedologically and socially differentiated evaluations can be made of soil quality.

In The Gambia, those benefiting from wet rice cultivation through the imposition of large-scale irrigation projects might not regard the resulting water-table reduction and acid-sulfate soil activation as a degradation problem as much as those growing crops on alluvial soils in tidal flats (Carney 1991, 43; Engel-Di Mauro 2012a). Ascribing a degraded status to such soils is to critique the political scheme that brought the expansion of cash-cropping as wet rice. It can be an implicit way of siding with those displaced by the imposed irrigation project and against the multi-national institutions behind it. Becoming aware of this enables the sort of interaction with Mandinka communities that helps identify which soils are useful in maintaining local livelihoods (which may not be organized in an egalitarian manner, and this would be another political struggle that would have to be based on local understandings, not a superimposed Eurocentric notion of socialism) and which soils require attention for remediation relative to subsistence, rather than marketable crop yield, bearing in mind that the two production orientations, subsistence and profitability, may coincide at some point in time and not in others.

Accelerated erosion by way of mass movement is not only an underappreciated process (Bennett 1939, 281–298; Blaschke, Trustrum, and Hicks 2000), but over small areas can be beneficial to creating cropping systems downslope in steeply sloped areas, like the Chimbu district in Papua New Guinea (Brookfield 2001, 166). To claim this soil-forming process as a form of soil degradation would not only be to deny the pedogenic value of Chimbu practices, but also to ask for, in a context of national state and foreign capitalist intrusion, the possible marginalization of the Chimbu people with the excuse of soil conservation. And it would be the marginalization particularly of the women in those communities who do most of the crop growing related to accelerating erosional movement in limited areas. An iterative process between a soil scientists and Chimbu soil users, as well as with Chimbu communities generally, generates the possibility of determining the kinds of soils that are degraded relative to fulfilling the attainment of physiological well-being for everyone in a community[26] and to shifting and contrasting local objectives.

A third and final step is to describe soil status (quality) according to whether it helps fulfil everyone's needs in a community and contributes to developing or maintaining egalitarian relations. Those who continue to apply conventional (absolutist) notions of soil degradation superimpose preconceived notions of productivity and are assuming a political stance that can contribute to deleterious consequences to local inhabitants and that can lead to counterproductive measure in terms of soil conservation (e.g., Bell and Roberts 1991; Blaikie 1985; Reij, Scoones, and Toulmin 1996). If a database were to be constructed from such information, it would have to enable input resulting from discussions with people living with the described soils and incorporate a redefinition of soil degradation as contingent on local circumstances. This implies giving up the idea of making units comparable for global assessments on the basis of abstract, decontextualized biomass indices or ecosystem provisioning, as currently in vogue. Places would have to be compared relative to eco-social context, so that it will be possible to discern constructive from destructive human and nonhuman impacts, relative to different social positions. It is admittedly difficult to develop a mathematical model that could represent this endeavor and perhaps it is best to avoid such model building for this kind of analysis. The advantage of this proposed perspective is that it is possible to recognize the same alterations on comparable soil types in different parts of the world as negative in one place and positive in another, something current prevailing approaches to soil degradation assessment seem unable to fathom (cf. Bakker et al. 2008).

To some extent, this alternative road has already been charted by others, especially by way of enabling substantive input from below and the combining of different kinds of knowledge (e.g., Reij, Scoones, and Toulmin 1996; Stocking and Murnaghan 2000). Even among more mainstream scientists, there is sometimes an awareness of wider social contexts wherein soil degradation is understood. Verheijen et al. (2009, 29) recognize that under Marshall Plan conditions, following World War II, acceptable rates of accelerated soil erosion were pinned to their effects on crop yield in Western Europe, rather than total soil volume or habitat for other organisms. Of course, there is little understanding shown by these scientists that productionism was associated with the expansion of agribusinesses (i.e., profitability) and a sometimes directly violent reconfiguration of capitalist relations in the farming sector (e.g., police shootings of farmers protesting for land redistribution in Italy in the 1940s and 1950s), but at least there is an inkling of awareness about historical social change and how it affects scientific practice. Boardman (2006, 75) also sees that soil degradation beckons asking questions that "stray from the strictly scientific arena." However, such neat isolation of science from society produces some amusing lapses. Consistent with this view of science, he can envisage human impact free of social processes. It is thus that he can misrepresent Blaikie's (1985) thesis as the "recognition that degradation occurs because of people–land relationships often involving social and economic opportunities and constraints" (Boardman 2006, 74). At this point, one may well speak of people birthing themselves.

The underlying problem is that viewing science as if separable from the rest of society impedes scientists' ability to look critically upon their own practices and notions and see just how political they are. There is an inherent contradiction between a claim of value-free statements (neutrality, objectivity) and the actual and unavoidable practice of taking sides (for preserving soils, for the superiority of a scientific approach, for or against defining soil loss according to crop yield requirements, etc.). More critically minded scientists understand the internal contradictions imposed by such an ideology of science, but have to tread a fine line in the context of a majority of scientists and institutions that uphold the self-serving mythology of scientific objectivity. There is hence an understandable reticence in coming out politically in a social milieu pervaded by often reactionary political convictions, whose existence is denied or brushed under the carpet of value-free science. However, in the left generally, there is little to no support for scientific work on physical environments. This may be one reason for a lack of development of clearer linkages (not subordination of one to the other) made between leftist politics and scientific approaches to environmental degradation.

CHAPTER 5

CAPITALISM-FRIENDLY EXPLANATIONS OF SOIL DEGRADATION

A feature article to a *National Geographic* special on soils (Mann 2008) begins with a photograph of a showcase soil conservation success story from the Coon Creek catchment, SW Wisconsin (U.S.). This is contrasted on the following page with another photograph from the loess Plateau of Northern China, a landscape ripped apart by massive gullies tens of meters deep. This is followed by images of people associated with different land uses and soil in four countries: U.S., China, Niger, and Syria. The story starts with Wisconsin farmers operating heavy equipment that tends to result in soil compaction. The next stop is Dazhai, famous for the controversial self-reliance farming campaign of the 1960s, where replacing forests with cereal crops eventuated in a soil erosion disaster. Successful counterbalancing experiences since the 1980s at Gaoxigou, not too far from Dazhai, are quickly recast as largely ineffective because of inadequate or perverse incentives imputed to centralization (cf. Ho 2003). The reader is then whisked away to the Sahel and introduced to the prolonged drought that turned huge areas into famine-provoking degradation. Thankfully, the reader is spared invectives against pastoralists (the livestock overstocking thesis) that used to pervade writings on the Sahel. Instead, costly mega-projects such as those in Keita, Niger, are described as ultimately self-defeating and contrasted with existing and more effective indigenous water conservation techniques. Dryland farming in Syria never materializes. Instead, and suddenly, attention is drawn to miracle carbon-grabbing human-made soils, the Amazon's *terra preta*, deemed to help save the world from global warming. We learn here that tropical country poverty is partly due to generally nutrient-poor soils, which could be overturned through judicious incorporation of charcoal, as Indigenous Peoples once did, to create *terra preta*. Improving the lot of "the poor"—colonialism, slavery, and genocide treated as inconsequential as relations of domination within countries—will compensate for the planet's trashing by "the rich." This sanguine interpretation of the world is then brought back to the continuing problems in Europe and Euro-descendant settler colonies in North America, where apparently soil compaction reigns. A comment from David Montgomery completes the article with a warning that world population growth will force us all to pay attention to soil. Throughout this stern yet hopeful treatment of soil degradation, one is given the impression that if only people were to have more direct control over land, soil degradation could be prevented and degraded soils reclaimed more effectively.

This whirlwind soil degradation tour captures much of the imaginary among concerned scientists and environmentalists, likely at odds with most government officials and technocratic academics who tend to blame locals for environmental problems. It is a political expedient that only sees ill-conceived incentives and policies as main stumbling blocks to resolving soil degradation problems. In much environmentalist narrative, the matter is about restoring a presumed lost harmony with soils. In other, technocratic versions, it is to pave the way for continued prosperity or to enable sheer survival in the face of demographic overshoot. It is a simple, almost Manichaean world. Even the well-intentioned bureaucrat is tangled in a bundle of "Political and economic institutions . . . not set up to pay attention to soils" (Mann 2008, 106), in contrast to the local farmers and allied enlightened do-gooders that usually know best. Remove the cumbersome or inappropriate government hurdles, presumably by tweaking laws, and soil degradation will eventually go away.

This division of the world into two camps—the small and local against the big and foreign—is reinforced in the subsequent one-page report on Haiti (Bourne 2008), where at least the odious history of slavery and post-independence repression by France is acknowledged (not so with multiple US invasions and dictatorships, past and current). Food shortages are partially blamed on centuries of soil erosion and partially blamed on unfavorable international price imbalances. A USAID director's recommendation to sell mangoes and import rice is pitted against an NGO ecologist advocating for greater local food production to solve hunger. And so it is that in this fable the cavalier meets the ingenuous in a strange landscape of fatally eroded soils that somehow provides enough mangoes for export or enough rice to fill local empty bellies. Instead of overthrowing foreign and local capitalist domination, securing reparations from colonial powers, taking over and redistributing land, and seeking the establishment of egalitarian communities, Haitians are supposed to accept either a plantation system or a meagre diet. It may be of little coincidence that oppressed Haitians are excluded from this dialogue, even figuratively.

Conventional soil science abounds in such ready-made dualistic representations of the world. However, this (petit bourgeois) defense of the small and local against the big and foreign is the obverse of a once overwhelmingly predominant (technocratic capitalist) reprimand of the farmer (or land user, presumed ignorant and/or over-breeding) by the knowledgeable and far-seeing expert. What is considered superior to one ideological position is inferior to the other. There are those that attempt to balance two of the components involved (farmers and scientists) by invoking the importance of local knowledge in combination with an external science, and I have already discussed these ethnopedological viewpoints, but such endeavors do little more than reinforce the dualism by turning the technocratic position into one of paternalistic understanding. They also do not confront issues of colonialism, multiple-scaled oppressive arrangements, and the like. It is not the task here of tracing the histories of these two kinds of capitalist ideologies, but at least by identifying them one can start appreciating how they affect soil science and the knowledge produced thereby.

Both kinds of dualisms are rendered possible by presuming a set of separate, sometimes reified units without any history (e.g., farmer, overshooting population, government, market) and connecting them through cause-effect chains or feedback loops (e.g., incentives, policies, institutions, land management). It would not be possible to maintain such dualisms if one were to acknowledge, for example, the equally legitimate production of knowledge but differing objectives involved in farming soil and explaining them scientifically or the overlap between using and studying soils common to both farming and scientific communities (e.g., Altieri and Hecht 1990; Brookfield 2001; Stocking 2003; Zimmerer 1993).[1] Likewise, such dualism would fall into disarray if one concentrated on the overarching processes begetting markets, governments, and the like, and constituting social roles, like farmer and scientist.

Arguments about soil degradation in soil science often tend to be formalized via flowcharts and sometimes attempts are made to abstract complexities through mathematical expressions or models. In themselves flowcharts, models, and equations are not problematic, if used as aids in conveying an explanation or just to systematize information or if they are developed to analyze processes as mutually constitutive, focusing on interconnections and change. Levins and Lewontin (1985, 146–147, 156–158), for instance, have demonstrated how such analytical techniques can be put to dialectical use, so that contingency on system structure, external influences, historical change, and duration of observation can be addressed even with relatively simple correlations of paired variables. Much of soil science (as all mainstream sciences), in contrast, is not only replete with atomization of variables or factors and reified structures (e.g., "the market," "soil fertility"), but also pervaded by the systematic exclusion of key explanatory factors, such as capitalist pressures for profit-making, gendered soil use, and racist conservation policies. Worse, the inclusion of social factors like "population density," "economy," or "government policy" are introduced without any justification, explanation, or analysis. Most explanations of soil degradation are therefore reductionistic or decontextualized abstractions, asserted preconceived notions about the causal factors involved, such as "socio-economic status" and "soil resilience." They are treated as if isolated from each other instead of interconnected processes that participate in and are part of the making of an overall structure, such as a complex of social relations and soils (Levins and Lewontin 1985, 132–160).

In some respects, especially when it comes to social processes, prevailing scientific explanations reflect, clothed in technical expert language, the sort of common sense notions that appear in the pages of newspapers or magazines like *National Geographic*, where historical analysis amounts to one-line descriptive statements (or succession of facts) and the contending actors or forces virtually pop out of nowhere. These devices imbue theories that scientific experts develop to explain soil degradation and to formulate ideas about what to do about soil degradation. They are often presented under expressions like "causes of soil degradation" (e.g., Lal et al. 2004, 11; Steiner 1996) and presume an attendant effect, in unidirectional and often linear fashion. The task here then is to expose the problems with this kind of unacknowledged theory-making because it leads to misidentifying the (social) sources of the soil degradation problem and produces ill-conceived notions of what should be done. Thankfully, this endeavor can build on existing critiques of "received wisdom" directly relevant to soil degradation (e.g., Leach and Mearns 1996; Zimmerer

1993), but it is sobering to note that such facile argumentation on soil degradation persists even while critical works are acknowledged and praised, as in Boardman's deforming appropriation of Blaikie's work (Boardman 2006).

Predominant Theories

Decades ago, Blaikie (1985, 53) identified four major forms of reasoning pervading conventional notions of soil conservation that emerged from "a colonial, Euro-centric and messianic intellectual frame of reference." These are (1) circumscribing the theme to issues of physical environments, (2) presuming over-population as the problem, (3) blaming soil users (land managers) for mismanagement, and/or (4) a lack of or not enough capitalism (see also Bernstein and Woodhouse 2006). Blaikie was prescient in deeming "the theory and practice of soil conservation" changing "often in directions that are not very promising." It seems that the directions Blaikie noted have culminated in a winnowing down to population pressure and mismanagement narratives, with a resurgent civilizationist (catastrophist) emphasis. The old technocratic trick of rejecting everything out of hand that does not solely relate to physical environments is more subdued these days, but remains a strong undercurrent. There is in contrast much more venturing by soil scientists in reading socially critical works or in considering social processes and incorporating them into their explanations of soil degradation. But soil scientists' highly superficial understandings of societal research are manifested in their misrepresentation and distortion of findings and arguments. Capitalism is also now typically the undisputed point of departure. After all, societies not overwhelmed by capitalist encroachment are rare, especially since the early 1990s. This may be ironically advantageous, as a few soil scientists, at least, are starting to pin the destruction of soils to capitalism, even if, almost as a test of faith, deprecating communism. Hence, salient forms of reasoning have continued to be modified versions of demographic determinism and managerialism, with an added preoccupation with "sustainability" expressed as anxiety about the collapse of civilization. These three modes of explanation are deeply inter-related. They all concentrate on (if not blame) the least influential people or shift the analysis to the least relevant processes. These are ways in which scientists actively participate in the political project of denying the socially systemic character to the problem of soil degradation.

Civilizationism

Many have appealed and continue to appeal to the specter of "civilization" collapse to justify their alarm or concern over soil degradation (Bennett 1939; Carter and Dale 1974; Dregne 1982; Eckholm 1976; Hillel 1991; Hyams 1952; Lal 1990, 10, 2007, 52; Lowdermilk 1953; Minami 2009; Whitney 1925; Wild 2003, 23). There is actually little to no evidence supporting this civilizationist variant of catastrophism, the contention that soil degradation in antiquity resulted in collapse. The often cited collapse of Maya civilization, for example, reveals the narrow-mindedness about what constitutes civilization more than any linkage between soil degradation and social change. To put the matter plainly, Maya civilization exists to this day and it was conquest that led to its current condition (Sharer 2009, 762–763; Turner and Sabloff 2012). Similarly spurious is the much cited link made by Lowdermilk (1953), based on little more than field observation, between soil degradation and the decline of southwest Asian civilization (e.g., Sumer, Balylonia, Akkad). The timing leading to such declines does not match up with soil degradation chronologies or any putative soil erosion cycles, as often asserted (e.g., Hillel 1991; Montgomery 2007a/b). A combination of other factors can just as well explain their demise (e.g., Fernández-Armesto 2001, 186–192; Orland et al. 2008; Weiss et al. 1993).

In light of such argumentative sophistication, there appears to have been little progress since the 1860s, with the relatively prescient musings on human impact by Élisée Reclus (1869, 753–757) or George Perkins Marsh (1874, 6). They may not be renowned for any preoccupation with soils, but they both realized the importance of social oppression in spurring and shaping human environmental impact. Closer to soils research, Milton Whitney, the first head of the USDA's Bureau of Soils, viewed agriculture as contingent "in part upon the climatic conditions, in part upon their soils, and in part upon the inclination, skill, social conditions and political conditions of the men" (1925, 185). The importance of political processes in determining the trajectories of social systems in relation to environmental impact was not lost to these earlier authors, unlike many current counterparts. Lastly, and more importantly, bemoaning the loss of authoritarian, often war-prone social systems (e.g., the Roman Empire, Babylonia) shows what sordid politics civilizationists espouse. It is troubling to find some leftists internalizing such inherently reactionary viewpoints (Chew 2005; Foster 1994, 37–38; Magdoff and van Es 2000, 7; Mazoyer and Roudart 2006, 182).

Populationism

Civilizationist delirium aside, the main contention many of the same above-cited authors posit is population growth causing soil degradation. Populationism, as Angus and Butler (2011, xxi) more precisely describe it, is a set of "ideologies that attribute social and ecological ills to human numbers." It is a consummately racist patriarchal argument that displaces a problem of capitalist relations mainly onto women's bodies (Hynes 1993; Mies and Shiva 1993; Sachs 1996; Salleh 1997). A common specious argument and perversity of the evidence (Schwartzman 2009, 30), it is even slipped in soil biochemistry texts (e.g., Haide and Schäffer 2009, 54). One hardly needs to travel to Machakos (Kenya), famed for a study showing soil stabilization with population growth, to find the incongruity of populationism. The matter is transparent in areas such as the northern banks of the Dráva floodplain (Hungary), where soil acidification problems arose with a historically falling population (Engel-Di Mauro 2003). For an Andean area of Bolivia, Zimmerer (1993) showed rising erosion rates resulting from labor shortages, rather than demographic expansion. A study conducted in the highlands of Thailand showed population growth resulted neither in farming steeper slopes, nor in deforestation (Forsyth 2003, 224–225). Pieri (1992, 114), focusing on the West African savannah, describes the lack of correspondence between soil fertility and population densities, explaining the discrepancy by the fact that farming practice is a decisive factor. Many other such cases exist and it is sheer obduracy to insist on population pressure. It befits the sort of arguments Blaikie and Brookfield (1987, 2) identified as "environmental fundamentalism," but their occurrence is more widespread than environmentalist circles.

Montgomery's above-mentioned intervention in *National Geographic* well illustrates the populationism that pervades scientific story-telling. Allusions to population growth as a major (if not the) source of soil degradation is a repetitive refrain in soil science. However, soil science populationism is mainly perfunctory, unlike what has been identified elsewhere (Harvey 1974; Hynes 1993; Smith 1996). There is rarely any claim to resolving soil degradation through population reduction. It is a rhetorical device enabling soil scientists to avoid taking responsibility for the political content of their work, displacing attention to matters at best indirectly relevant to the topic of soil degradation. By doing so, they dissemble and caricature rather than explain.

An eminent early and influential example is Hugh Hammond Bennett, the founder of the US Soil Conservation Service. There are other contemporary examples of populationist conservationism studies by others, especially from areas under the British and French Empires (e.g., Blaikie 1985; Swift 1977; van Beusekom 1999; for a St. Vincent exception, see Grossman 1997), but it seems that the globally reaching US variant has not received due attention. Bennett, embodying this variant, recognized the destructive tendencies of a society, the US, where soil is viewed "as a field for exploitation and a source of immediate financial return" (Bennett 1939, 13). He took account of this soil-degrading "commercial exploitation" in other areas of the world as well, such as "Ceylon" and "Netherlands India," under British or Dutch rule (p. 919). Yet his description of non-European societies is about population growth inducing accelerated erosion, while his esteem was easily captured by mass-murdering authoritarian regimes imposing soil conservation measures. In "Africa," for example, "the native population . . . increased rapidly with the establishment of peace and the control of disease" thanks to "white settlement," but the natives' "primitive agriculture became destructive" because of the decline in land available to them as a result of "the influx of white settlers" (p. 922; see p. 918 for an South Asian variation on the theme). However, he would reserve the term "invaders," rather than "settlers," for conquering non-Europeans (e.g., "Mohammedans"), and their invasions are framed often as a direct cause of soil degradation (e.g., p. 916). Explanations are also much more nuanced when it comes to accelerated erosion in Europe, with deeper analyses involving the impact of social and technological change, pressures on peasants, the effects of urbanization, and a description of shifting property relations, among other social processes (pp. 905–911). There is even praise for fascists in Italy (the term fascism never even appears) "recreating the agricultural productivity of classical times" (p. 904). For places like the U.S. and Australia, multiple genocides and slavery do not even merit the slightest allusion. For Bennett, in such places of "white settlement, . . . nations developed unhampered by indigenous population" (p. 922). As for previous soil-destructive impacts by colonizers, they can be explained away as mistakes due to the rapidity of "economic progress" or "development" (p. 922), such as the above-mentioned pressure of "commercial exploitation" (p. 919), out of which now more enlightened authorities are learning and for which they were developing conservation measures.

Populationism has remained to the present almost as a default research assumption. Among others, Eckholm (1976, 18) and Brown and Wolf (1984, 5–6, 12) see pressure on farmers to use land badly because of population growth and consequently rising crop demand. Pimentel (1993, 2006) similarly uses the lopsided distribution of malnutrition and recurring famines as proof of the seriousness of soil degradation and presumes population growth as main culprit (see also Dregne 1982, 9; Hillel 1991, 17). The connection between mouths to feed, food, and soil may seems obvious until one thinks about the diversity of environmental factors (not just soils) affecting crop growth, the widely differing requirements of crops and cropping systems, and the forms of social relations that lead to highly uneven food distribution and consumption. Pimentel in particular might wish to reconcile his notions with what he has recently theorized with another author, which is the postulate that population growth is driven by food availability (Hopfenberg and Pimentel 2001). Leaving aside the absurdity of this more recent argument, where varying levels of food production just happen and political struggles do not exist,[2] if food production is supposed to decline because of soil erosion, as assumed by Pimentel, it is most remarkable how soil erosion has made no difference on population growth, which continues, and (by Pimentel's same faulty logical inference) on food production. In the same volume edited by Pimentel, Khoshoo and Tejwani (1993, 121) even go so far as to claim that the land mismanagement they identify as causing widespread soil erosion in India is the consequence of population and livestock growth, despite initially tracing the problem to colonial history. These attitudes are striking, considering other contributions to the volume, like that of Hurni (1993) or Edwards (1993, 153–154), who refer to historical social processes and find a rather different justification for their soil erosion concerns.

Láng (1994), in an opening article to the proceedings of an international congress on sustainable agriculture, begins by displaying figures on world population growth. Lal (1994), rehashing earlier writing (Lal, Hall, and Miller 1989) and trying to legitimate his view of soils as production treadmills, follows suit with data on the ever declining global trends in arable land per capita, an oft repeated approach to soils figures (e.g., Khoshoo and Tejwani 1993, 120; Markewitz and Richter 2001, 11) that are in many cases unreliable (Bruinsma 2009, 238). Lal, Hall, and Miller (1989) were nevertheless correct in their prediction of decreasing per capita arable area over time. It is 0.2 hectare per person, according to the most recently available FAOSTAT estimates from 2011. But such averages are deceptive, even if estimates were accurate, given that the FAO category of "arable land" excludes permanently cultivated and pasture areas and especially given the extreme worldwide inequality in land holdings, food distribution, and decision-making processes over what is grown where, all factors inexplicable by population growth. Abrol and Sehgal (1994, 129) restate the equation for the Indian context with the well-meaning intent of protecting soils to produce more food and "alleviate rural poverty" (it is unclear how these processes are linked). But Láng dares go further. In his view, population growth determines all other processes in society and the "future of the world" is tied to how population growth relates to energy consumption and environmental protection. It is a mystery how environmental protection, a consummately political process, is independent of population growth in one sentence and is then determined by population growth in the following sentence. Leaving logic aside, there is also an interesting occurrence of self-restraint in the populationist model, and that restraint enters its full force when the author writes about his own country. When it comes to discussing agriculture in Hungary, after the obligatory praising of free-market democracy typical of the 1990s, the author's populationist view rapidly fades away. It would, after all, be absurd to insist on demographic determinism in the case of a country experiencing net population decline. Yet even within the same volume, data and discussions directly contradict such populationism. In the case of "Africa" (i.e., tropical parts of the continent), Izac (1994, 82) finds that farmers' adoption of sustainable practices is shown to depend on incentives that are not necessarily connected to capitalist dynamics (i.e., "yield stability" rather than cash-crop revenue).

The obdurate populationist will still claim that the recent spread of more destructive land use is "due largely to increasing population pressure" (Ellis and Mellor 1995, 223–224), an argument denying huge consumption level chasms and associated environmental impacts. At times, population pressure is represented as a special attribute of non-Europeans. In a report to the German government, Steiner (1996, 28) places demographic growth, a "well-known problem in most developing countries," as the central cause inducing contraction of available land, leading to greater intensification and the spread of farming in less suitable places. Only with adequate market access can disaster be avoided, as the oft-cited example of Machakos District (Kenya) supposedly teaches us (see also Wild 2003, 1–2, 151). The author, unperturbed by self-contradiction, cannot fathom the well-known soil-degrading processes of forced displacement and economic deprivation, especially in "most developing countries," or of lucre in places like Germany. This implicit argument that non-Europeans are prone to self-inflicted soil degradation through a lack of population control is diffuse. Describing human impact in the Petén Maya region, Beach postulates that “population growth has led to increased logging, ranching, fuelwood gathering, and more extensive and shorter fallow *milpa* agriculture” (Beach 1998, 380).[3] Such argumentative simplicity seems attractive enough to Montgomery, who reprimands the same landless Mayan peasants for having “turned much of the region’s forests into . . . *milpas*.” In his view, a “twentyfold increase in population from 1964 to 1997 has transformed the region from nearly unbroken forest to a nearly deforested landscape” (Montgomery 2007a, 76). Such claims can be dismissed on their own merits, according to the evidence presented. Namely, population growth does not correspond to the spread of milpas (evidence points to a two-decade lag). Furthermore, a thousand years of continuous Maya presence has not led to deforestation or population growth until more recently, which should be an impetus for investigating causes other than those hastily considered.

Similarly, Drechsel et al. (2001) assert that soil nutrient depletion in Sub-Saharan Africa is due to rising population levels. Responding to critical scholarship (e.g., Scoones and Toulmin 1998), they conclude (exceptionally for soil science discourse) that policies should be primarily aimed at reducing fertility rates. They seem remiss of the mismatch between soil nutrient and rural population density data[4] and by the reliability problems of simulations, where variation in soil characteristics (e.g., clay mineralogy) are poorly addressed and processes like pH and CEC (highly influential of nutrient availability to plants) are not even considered in the model (Stoorvogel and Smaling 1990). Nutrient depletion, furthermore, does not reveal the amount of total and potentially available nutrients, so it is misleading to evaluate the impact of net nutrient extraction relative to cropping system (see also Scoones 2001, 10–11). These issues alone make the conclusions at the very least premature, but even more troubling is the authors’ presumption that farmers “invest” in soils when market conditions are favorable and their dismissal of tackling the conditions under which farmers operate because they are “difficult to change” (Drechsel et al. 2001, 257). Capitulation to capital is presented as a matter of practical solutions.

For many at the FAO, it is treated as a given that population density is “a factor influencing land degradation” (Bot, Nachtergaele, and Young 2000, 33). Plotting the degree of soil degradation severity against regional population density figures, the authors happily find what they knew all along. As population density increases, so does the severity of soil degradation. It matters little that GLASOD, the soil degradation assessment used, is faulty if not inaccurate, and that the spatial resolution of instances of soil degradation is much too coarse to test this assumed linkage (Chapter 4). But the matter becomes even more fascinating when the authors exclude "Europe" from analysis "because its high population densities are mainly associated with urbanization" (ibid.), which is apparently a rare phenomenon elsewhere, like the large Tokyo-Yokohama or Kolkhata-Hooghly metropolitan areas. The contortions circus intensifies when they admit that Asia and Pacific regions also do not fit the expected pattern. Where there is higher population density, there is less degradation. Severity of degradation is matched with lower population density, as in Europe and North America. Yet the exceptionality of Asia and Pacific regions is not enough for special treatment, unlike Europe. Perhaps if Europe were to be included, one would have to confront the huge disparities in regional resource consumption levels, rather than mere population densities. What is more, according to the GLASOD data there are no areas of very severe degradation in North America. In a sleight of cartographical hand, thousands of extreme cases of pollution, like Toms River, New Jersey (US), magically disappear. Nevertheless, given that there is no straightforward relationship between population density and soil degradation, the authors are forced to admit that "population density may be treated partly as a cause, but also to some degree as a consequence, of severity of degradation" (p. 34). Not content, they resort to describing known country studies, carefully avoiding "Western" places (e.g., Bosnia Herzegovina, but not Norway for highland regions). These case studies show the same equivocal results and force them to introduce other processes, like income inequalities, but not confront their own Eurocentric chauvinism.

Populationist arguments for Europe tend to be directed at the remote non-capitalist past, such as for the UK, where, "In general, erosion has been greatest at times of population pressure on the land such as in Romano-British and Medieval times" (Boardman 2013, 420), a perplexing conclusions when considering the currently much higher population levels in the same already eroded areas and the much greater land use intensity, by way of, among other means, agrochemicals and machinery.[5] But it is not always true that Europe is exempted from populationist explanations. Van Lynden (1995, 13), using GLASOD data, explains the problem as due the industrial revolution intensifying population pressure in "Europe" (i.e., the European Union of the early 1990s). Aside from a lack of any chronological analysis relating changes in population size to impacts on soils, total population growth in the European Union is low when compared to other areas of the world yet the degree of soil degradation is relatively high. Country-specific studies also dispel any direct link between population levels and the occurrence of soil degradation. In Germany, Hungary, and Poland, for instance, there are areas of soil degradation in a context of net population decline, in contrast to Ireland, France, and Spain, with relatively high population growth rates and yet no appreciably greater extent of soil degradation. Or, if one prefers greater specificity, soil sealing is not coextensive with population size or density, as shown even by data from institutional organs, like the European Environmental Agency.[6] In a historical period when overall population growth in the European Union is largely immigration-led,[7] to claim population pressure as a principal cause of soil degradation raises suspicions about the political aims of the authors, particularly in the face of contradictory evidence.

Populationism is an art in blaming victims and choking intellectual exploration. As Stocking (2003, 1357) notes, "Doomsday scenarios of increasing population and declining soil resource quality fail to capture the diversity of soils, while presenting the worst-case outliers as the typical situation." It is debatable whether outliers even prove a wholly demographic cause, as multiple factors are typically involved, but the paucity of population control advocacy in soil science is notable. Populationism is then possibly a strategy to attract attention to the importance of soil conservation and thereby of soil scientists. Or, it is strange that soil scientists should have trouble understanding that high crop production and people being fed or urban area enlargement and people being housed are emphatically not coextensive processes in free-market democracies. Not so to populationists like Pimentel, who have found their god Malthus in soil erosion. Soil formation is geologically slow and human-induced erosion is quick as lightening. Geometric soil production thereby meets exponential soil destruction in a theatrical play as plausible as overnight global glaciation.

Disconcertingly, leftists at times resort to populationist arguments, too. Foster (1994, 23–24) recycles the institutional view that pits demographic expansion against total arable land. Moore partly succumbs, like Chew (2005), to the assumption of a direct relationship between demographic expansion and resource consumption. Hence, deforestation in the sixteenth century is imputed to a combination of population growth and a rise in cereal exports resulting from increasing dependence on a Dutch-dominated international economy (Moore 2012, 85). However, given the dearth of records on peasant activities and demographics, it could be just as easily assumed that deforestation was wholly linked to external pressures and coercive measures from landlords.

The Soil Mismanagement Thesis

A similar logic is deployed about soil use and it is often explicitly linked to demographics. Given exponential population growth and diminishing amount of soil area available, the question becomes how to manage soils so that everyone can be fed. Enter, therefore, the valiant soil scientist telling soil managers how to improve their ways. As experts know their subject matter well, it would seem obvious that their counsel should be authoritative on topics within the remit of their expertise. But management is a social process requiring much more than soil science expertise. Furthermore, socially uninformed interventions have often failed in part by presuming locals have little understanding or relations of power do not matter (Brookfield 2001; Reij, Scoones, and Toulmin 1996). Such interventions can leave a particularly bad taste of patriarchal and supremacist arrogance, as in East Africa, where farming mainly involves women (Gladwin 2012 Rocheleau, Thomas-Slayter, and Wangari 1996). Undeterred, many still have no qualms about dispensing explanations and prescriptions without minding social processes or research.

Because it affects the largest amount of land area, agriculture is often fingered as the major cause of soil degradation and a popular target of intervention. Lal (1990, 10), for one, is in no doubt and fully concurs with Bennett (1939, 12): “Soil erosion began with the dawn of agriculture, when people began using the land for settled and intensive agriculture.” Not a few soil scientists find this a plausible explanation, even if they might nuance it (e.g., Blum 1998a, 4).[8] The task then is to study and diffuse soil-conserving techniques to improve management, but, to add to Brookfield’s observation (2001, 157), it is astonishing how it is that soils have not completely vanished after thousands of years of farming mismanagement, as many would like us to believe (Khoshoo and Tejwani 1993, 118–120; Montgomery 2007a).

There must be more to human impact than agriculture, then. We have some hints from other authors about this. From within an international institution context (the FAO), the emphasis tends to be on land use. Soil degradation occurrences are therefore also due to deforestation, overgrazing, overharvesting, and industrial pollution (Bot, Nachtergaele, and Young 2000, 31–32; Braimoh and Vlek

2007; Fullen and Catt 2004; Oldeman, Hakkeling, and Sombroek 1990). However, when it comes to explaining land use, a rare treat, scientists come up with bizarre statements, such as agricultural intensification in temperate areas resulting from growing season brevity (Ellis and Mellor 1995, 222). A glance at historical evidence, exhibiting many instances of intensification in the tropics and a lack of intensive systems in many temperate regions, quickly dispels such a view.

Blum (1998b) draws attention to urbanization and its associated spread of soil sealing of, among others, farmland (suddenly redeemed!), and the diffusion of forms of agriculture where they do not belong (presumably industrialized forms, given references to agrochemicals use and the like). He has a general theory that sees soil degradation as caused by the gradual worldwide transfer of certain disruptive land use techniques (and associated biota) largely from north to south, and the development and spread of industrial activities. The intensification of land use related to this twin transfer of land use techniques and industrialization is, to return to a broken record, due to population growth (populationism can also be thought as an elementary confusion of putative correlation with causation). Regardless, soil scientists recognize that more than farming is involved in soil degradation, but many seem to think that the causes have been long in hatching out to their full potential (it took exponential population growth to make the problem obvious). This argument for the ancient origins of soil degradation is one way soil scientists contribute to deflecting attention away from the specifically capitalism-induced and unprecedented nature of the problem. Yet every soil scientist who actually probes into the matter finds that soil degradation is mainly a product of the recent past (Boardman 2003; Richter and Markewitz 2001). Unfortunately, even the recognition of different social systems is rare, except perhaps the notion of "civilizations" (Hillel 1991, 2008; Montgomery 2007a), or the idea of "developed" and "undeveloped" (Boardman, Poesen, and Evans 2003). Reference to a generic humanity or non-descript societies is most excellent reasoning for those wishing to avoid political discomfort.

Lal et al. (2004, 11–13) delve a little more into the "socioeconomic and political causes," by which they mean a list of things like "population density," "land tenure," "policy," "market," "political instability," and even "gender/ethnic equity." These are neither defined nor taken up in any analysis in the rest of the volume, where the effects of US government policies, allusions to growing environmental concerns and "market forces" (41) are discussed to explain land use change. These causes are on a par with "biophysical causes" (which strangely do not appear on the explanatory flowchart), like deforestation, tillage methods, and mining. In other words, soil degradation is caused by land use ("biophysical causes") and disconnected, timeless socioeconomic and political things. The analytical depth and breadth is breath-taking. Such statements or explanations are sometimes accompanied by descriptions of what are to be regarded as appropriate management practices or strategies to attenuate or combat soil degradation (Blum 1998a, 12–13; Lal 1990, 309–317). In themselves, such recommendations can be useful, especially if they have something new to offer to those actually using soils. However, they are typically remiss of three crucial processes: (1) existing knowledge production systems and practices outside institutional science, (2) external pressures on soil users, and (3) changes in environmental conditions induced from activities elsewhere.

Before identifying problems and offering remedies, soil scientists ought to find out what people already do and that have enabled them to live off the land across generations (for some more promising institutional alternatives, see Tengberg and Batta Torheim 2007). Regrettably, prolific and influential scientists like Lal tend to be explicit that, at least in tropical areas, it is "traditional agricultural systems" (Lal 1990, 316) that must be improved and along the lines of what they suggest, if, for instance, soil erosion is to be reduced effectively. It is a marvel to read what is on offer as "scientific crop management" (Lal 1990, 347), given how most of the examples described are from field experiments, not from actual farming communities, and how many recommended practices are common to "traditional agricultural systems." It takes some arrogance to presume that farmers do not know how to select crops suited to local conditions or "that can establish a quick ground cover" (Lal 1990, 327), or that they do not know the advantages of manual weeding (339). Then again, it is doubtful that agriculturalists read such recipe books, which seem aimed more at a technocratic audience.

One example of scientific intransigence itself hindering the identification of causes is how "traditional" techniques like polyculture are treated. Lal (1990, 317) makes the startling discovery that polycultural techniques are superior to monocultural ones in restraining erosion and appropriates them as part of the panoply of conservation interventions. This is in spite of widespread knowledge that polycultural methods have been widely practiced in many communities living in the tropics. Not only does polyculture help reduce erosion, but also improve nutrient cycling efficiency, and mitigate weed and pathogen effects (Altieri and Hecht 1990; Brookfield 2001; Igbozurike 1978;

Mt. Pleasant and Burt 2010; Picasso et al. 2008). Were Lal and others really to abide by their own research results, they might explicitly advocate for policies favoring polycultural techniques, so as to reduce soil degradation. The fact that they do not suggests greater concern for profitable productivity over soil degradation. Notably, polycultural methods are being subjected to productivity tests (Griffith et al. 2011) for use in commercial biorefineries (biomass energy and chemicals extraction factories) and are being found wanting for reasons of "economics" (i.e., lower productivity than monocultures).

Another process elided by technical or scientific experts is the set of pressures from multiple sources that combine to hamper the development or the continuation of beneficial impacts or constructive soil use (Blaikie 1985). So, it is certainly a legitimate observation that soil degradation is courted by using land in ways that contradict capability (Khoshoo and Tejwani 1993, 119; Lal 1990, 309). The questions should then be how the criteria for defining capability are determined (Chapter 3) and why people are using land in an inappropriate way relative to soil properties, rather than presume that only technically qualified outsiders have the requisite answers.

A third process that tends to be eschewed is the changing environmental conditions linked to human impacts from far away or nearby. Mulitza et al. (2010) have recently shown that the nineteenth century colonial imposition of capitalist farming in the Northwest portion of the Sahel is associated with rising levels of dust generation and marine sedimentation, which implies greater erosion rates. This trend was amplified during the 1970s by prolonged drought. Another example of enduring effects of past impacts is the depletion of water supplies and soil aridification and/or salinization due to upstream damming for the generation of electricity or irrigation systems favouring a minority of (largely white) commercial farmers or other businesses. This describes what occurred, for instance, in Baja California (Mexico) as a result of damming the Colorado River (US), or in soils near the Aral Sea and the Amu and Syr Darja floodplains with the irrigation systems for largely market export-oriented cotton production during and following the Soviet period. Finally, global warming effects make for differential impacts on soils (Lal 2007). All these examples point to a combination of processes of environmental change that have little to do with local management practices.

The solutions proffered by such experts tend to be similarly blissful of context. For instance, Lal's (1990) land use recommendations involve an inventory of soils, climate characteristic, and "socioeconomic factors" (basically, the extent of mechanization and types of tools available). Blum (1998a, 11–13) would add to this more state intervention based on precautionary principles and greater international and national coordination and cooperation in studying the problem. What all these strategies have in common is the explicit push for scientific knowledge transfer and the establishment of incentives for soil users to adopt scientific recommendations. This not only ignores social relations that shape land use, but runs roughshod over people's own classifications about which soils can be used for what purpose and it imposes the sort of technical needs (lab facilities, reagents, coring equipment, etc.) that disqualify most communities from being able to carry out their own inventories (cf. Bradley 1983). Then again, the objective is not really feeding people, but reaching "high and sustained production" (Lal 1990, 320), instead of "maximum yield in bad years" (Blaikie 1985, 22).

Pointing to mismanagement by soil users is hardly new. However, the subject and the explanations given have varied and exceptional analyses have emerged. Prior to the 1930s in the US, for instance, the matter of soil management was viewed in terms of insufficient understanding of soils to "win success in agriculture in the production of food and clothing" (Whitney 1925, 14) or a matter of soil fertility for part of the urban business sector (Shulman 1999). The problem was the incompetence of the soil user, but rather than degradation, the focus of attention was under-production or production failures resulting from lack of knowledge, which was to be imparted by scientists and technicians (extension agents) or urban-based business interests in their intrepid struggle against social inertia. It is not that there was no soil degradation, but it was not yet recognized politically as a problem. As well known, the turn came about in the 1930s, with the subject shifting to a preoccupation with erosion. However, the causes of degradation were regarded as social, the result of combined institutional incentives, contradictions between profitable production and soil characteristics, financial pressures, and price-revenue linkages. The technocratic solution offered was imbued with paternalism and nationalism but multi-dimensional, from farmer education to price stabilization and government support. The policies resulting from USDA recommendations may have eventuated in markedly containing the erosion problem (Lal et al. 2004; Zobeck and Schillinger 2010), but failed relative to other forms of soil degradation, such as pollution, sealing, and acidification, and certainly succeeded in further removing people from farming altogether (Goodman and Redclift 1989) and reinforcing the dominance of settler colonial farming as an enterprise largely centered about white heterosexual maleness (Sachs

1996). Furthermore, these past policies contrast with the treatment and constructs of food producers elsewhere or of peoples under the yoke of US colonialism (e.g., Correia 2013; Leach and Mearns 1996; Prucha 1984).

Unexceptional Exceptions and Prospects for Internal Dissent

In a footnote for the first section dedicated to machinery and its relationship to the relative exploitation of workers, Karl Marx had this to say about the natural scientists of his day:

> The weak points in the abstract materialism of natural science, a materialism that excludes history and its process, are at once evident from the abstract and ideological conceptions of its spokesmen, whenever they venture beyond the bounds of their own specialty.
>
> (Marx 1867/1992, 352, fn. 2)

Modern self-appointed overpopulation and mismanagement theoreticians seem to exhibit such weak points all too well, but there is much more ferment within, even if largely misdirected as a result of woefully deficient political analysis (or of often unstated capitalist convictions). That is to say, there is some dissatisfaction with technocratic approaches that compels excursions into social causes, even if sporadic and limited in scope. These explorations into the social context of soil managers are typically carried out in industrialized countries, but there are important examples of more critical understandings of "developing" country contexts, as cited above (Hurni 1993; Izac 1994). Disappointingly, prospects for critical self-reflection through soil science history are stifled by self-encomiastic narratives of progress and heroism or sanitized descriptions of scientific practices passively responding to societal demands, a mystification of state and/or capitalist pressures on scientists as workers (cf. Bouma and Hartemink 2002, 136; Krupenikov 1981; Mausbach and Barker 2001; Warkentin 2006; Yaalon and Berkowicz 1997).

Overall, to my knowledge, Fred Magdoff is the only openly leftist soil scientist, especially evident in his writings for the socialist periodical *Monthly Review*. He, alongside agroecologists (e.g., Altieri 2009; Altieri and Hecht 1990), has also contributed to developing alternative holistic ways that challenge capitalist farming (Magdoff 2007; Magdoff and van Es 2000). However, the approach only targets its current technological basis, not the capitalist mode of production per se (e.g., sustainable practices are discussed in terms of farmer profitability). To address the latter, Magdoff's prolific writing has concentrated on farming, populationism, land politics, socialist futures, among other topics,[9] without developing an alternative soil degradation theory.

On the other hand, ethnopedological work challenges at least the mismanagement thesis by demonstrating local comprehension of soils and often more managerial competence than that of outsider technocrats (Brookfield 2001; Norton, Sandor, and White 2003; Reij, Scoones, and Toulmin 1996; Richards 1985; Zimmerer 1994). It is a laudable effort to bring legitimacy to knowledge systems of oppressed communities. As part of this overall aim, "ethnopedology helps validate scientific soil knowledge to assure that it is not only scientific but also locally relevant and functional" (Barrera-Bassols, Zinck, and Van Ranst 2006, 133). A main weakness is that soil scientists are assumed to have no ethnicity and the bridging between knowledge systems is remiss on power relations that can transform such bridging into another strategy of repression (e.g., using local knowledge to improve soil survey precision to benefit land speculators and dispossess locals). In other words, even while undermining technocratic approaches, ethnopedology suffers from a lack of critical self-appraisal and social relations analysis (see also Seth 2009, 379–380).

Otherwise, dissent is expressed largely as dissatisfaction with policies, even neoliberal ones. There is a tendency to promote smallholder private property in land. Sometimes, as in ethnopedology, efforts are made to legitimate knowledge systems outside those sanctioned by the state, but such efforts typically skip industrialized settings. Rarely, histories of colonialism or even slavery systems are acknowledged, but the matter is understood as a past of little bearing to current land use systems. Seemingly anti-colonial or otherwise critical perspectives also poorly conceal nationalist or small land-owner agendas.

Those taking issue with government policies or economic incentives, such as the European Union's Common Agricultural Policy, see farm management as only an immediate cause. "Socio-economic drivers," like government policies and "simple economic reality" like "short-term economic returns," are the ultimate causes (Boardman 2013, 423). In this, current soil scientists might be discovering past formulations, with causation divided according to micro- (farm level) and macro-social (national and international) factors and solutions found in nationalist (or now European Union) strategies of state intervention to maintain agribusiness competitiveness while conserving soils in one region (Bennett 1939; Hambidge 1938; Timmons

1979, 55–60). The extent to which the capitalist mode of production is taken for granted is breath-taking, as are the explanatory inconsistency and the inability to carry the analysis further by some simple questions. These could be what constitutes an economic return and why short-term gain is prioritized. Arguably, one could find the reason for this analytical complacency in an unwillingness to confront existing power relations. For when it comes to more powerful commercial farmers, responsibility for soil degradation shifts from soil manager to policy-maker and the problem shifts from mismanagement or overpopulation to "simple economic reality" or "political will" (Arden-Clarke and Evans 1993, 215). The main concern, particularly in the European Union, is harmonizing soil conservation policies with farmers' economic requirements, and, to the scientists' consistent chagrin, witnessing mostly a mismatch (Boardman, Poesen, and Evans 2003; Bouma and Droogers 2007).

The tendency for blaming food-producing people outside "developed" countries (or in the non-capitalist past) for using soils improperly or for having too many children and the curious deference for what are presumably mostly white male farm business owners, whose collective political influence likely out-matches that of soil scientists, points to a classist, masculinist, and racist tendency. However, in spite of soil scientists, soils research can be very useful towards a general critique of capitalist relations. The above-cited Lal offers useful information to critique capitalist (and state-socialist) approaches and environmental practices, like monoculture farming. Even more interesting are recent findings for countries like France and the UK that are indicative of the repercussions of neoliberal policies on soil erosion rates. These have markedly risen over the past 50–60 years because of the intensification of farming (e.g., machinery-induced compaction), the expansion of cropping into periods of high rainfall erosivity, and the eradication of parcel boundaries (e.g., hedge rows) that mitigated the transfer of eroded material. It is soil scientists themselves, not leftists, who point the finger at land consolidation as part of the cause (Arden-Clarke and Evans 1993; Boardman 2003; Chartin et al. 2013). The connection between the concentration of capital and soil erosion is thereby laid bare, but no leftist analysis is ready to catch the opportunity. Such contributions set important precedents and provide promising counterbalances to a morass of capitalism-friendly explanations.

Some researchers attempt to explain the occurrence of mismanagement itself. In part, the effort is to make findings useful to the formulation of government and international policies, especially in light of concerns expressed over soil degradation in Agenda 21 promoted by the United Nations Conference on Environment and Development (UNCED) at the 1992 Summit in Rio de Janeiro (de Haas and Friedrichsen 1996, i). This type of work is also related to an acknowledgement of policy failures in soil conservation in many parts of the world and the subsequent attention to rethink development projects in ways that are not detrimental to soils. It is an important step forward in that there is recognition that mismanagement is the result of social arrangements, rather than a cause in itself. But what usually ends up being highlighted is a list of factors that are treated as if they were independent of each other or assumed as causal without supporting evidence. For instance, the above-cited Steiner (1996), in spite of his obsession with population growth and his double-standards, finds other factors also affect soil use, like displacement of pastoralists. More recent approaches to land use are more nuanced in that they consider the complexity involved in relating highly variable social and ecological circumstances across the world. Soil degradation, in this view, remains linked to populationist explanation, but in the context of social changes due to "globalization" and shifts in policies. Recommendations, however, stress a need for improving world market conditions for "developing countries," especially smallholding farmers (Braimoh and Vlek 2007, 3).

Any promising dissatisfaction with the status quo tends to be channeled into priorities unsuited to developing critiques of power relations. Some of this can be sensed in technical debates over soil quality criteria, as described in Chapter 3. Justified concern over soil degradation is reduced to the development of a scorecard with a narrow set of characteristics conforming to requirements of white male-dominated capitalist farming in industrialized countries in mostly temperate zones. Much of the resistance to the institutionalization of soil quality scorecards is voiced by those acting as possibly unwitting representatives of commercial farmers that view with suspicion any fetters on how they dispose of their property. Davis and Miller (1997) observe that capitalism in formerly state-socialist countries like Poland has brought such a degree of economic insecurity as to hamper farmers' sustainable soil use. This generic smallholding farmer understanding is similar to that of Montgomery (2007a, 244), a self-confessed champion of private ownership by those working the farm (the "small farmer"). To him "Private ownership is essential" and small farmers everywhere should be market-oriented to some degree (Montgomery 2008). Hence, the problem of soil degradation would be greatly diminished if subsidies went to small organic growers, absentee ownership disappeared, agribusiness adopted no-till methods, and urban farming prospered (but see Engel-Di Mauro 2012b).

Commendably, Montgomery (2007a, 163–164, 230–232, 235) ventures much further than most soil scientists in a comparative analysis of social systems. He argues that soil erosion is a problem of both capitalist and “socialist” (i.e., Soviet) agriculture because resource depletion is not recognized in those systems. Hence, his attention turns to Cuba, an undeniably successful example of government-mandated applied agroecology. This is in spite of being, according to the author, “a dictatorship isolated from global market forces” and “a one-party police state.” In fact, by the author’s own admission, Cubans were better fed than the rest of Central America and the Caribbean (and many in the US), even before the early 1990s food crisis. But since evidence must fit the author’s private property ideology, he asserts that the establishment of “semi-organic farming” on the island was the outcome of economic pressures that forced agricultural reforms enabling more private farming, thereby “retreating from the socialist agenda” (p. 232). The author prefers the fanciful notion that Cuba has not been trading with many countries outside the Soviet bloc since 1959 and that, apparently, decades of US embargo enforcing isolation from most global trade managed to put no pressure on Cuban food production. Cuba is “socialist” when it suits the author and then it is “retreating from the socialist agenda” when “socialism” may put a dent in the author’s private ownership ideology. It is unfortunate that such promising analysis should so easily succumb to pastiche politics, like those prevailing in Green parties and movements, haughtily pretending to rise beyond and above left and right. To achieve such heights and transcendence, the typical maneuver is to subsume all socialist history and movements under the USSR (are Greens unknowing parrots of the Third International?) so as to declare them all as environmentally devastating or potentially so, just like big business (cf., Armstrong 2008; Schmidt et al. 2011).

For most of these authors, the issue is primarily one of enshrining private property as a primary means for farmer control over land, who either needs state-provided security or support or rentiers (big business) off their backs. Collective or communal ownership in many farming communities worldwide simply cannot be conceded to exist. Even so, how to reconcile multiple systems of land tenure or how private land ownership even happens are themes rarely explored, but when they are, much is revealed about the extent to which soil scientists believe in bourgeois mythology. For instance, Ashman and

Puri (2002, 114) trace the origins of private property and even class differentiation and industrialization to the "permanent settlement" necessitated by farming. Sedentarism inevitably makes people think of land as their possession, which explains why so many transient workers and highly mobile bosses are losing the sense of private property (if only they stayed put, they would not be prone to communism!). In some contrast, the less grandiose Bouma and Droogers (2007, 455) are more openly wedded to a version of democracy whose foundations are "the interaction between citizens and their society and government," with scientists like them facilitating and mediating such interaction on the basis of objective facts and, of course, private property. Soil degradation can be reduced or avoided by this sort of scientific involvement, as echoed by others (e.g., Boardman, Poesen, and Evans 2003), but this democratic approach seems only to apply to mostly land-owning, market-oriented farmers in selected parts of the world, where liberal democracy and thriving soils experts rule the land.

Aside from these more candid writings, work by soil scientists sometimes wander, even if minimally, into wider political context and even social history. These brief voyages outside one's intellectual territory are instructive about current prospects for any development of heterodox views within soil science. Inchoate recognition that soil degradation is linked to issues of resource control over resources is often derailed by uncritical acceptance of capitalist tenets. For instance, the above-cited Davis and Miller (1997, 4) posit that "freedom without security is meaningless," an indictment of the unbridled free-market ideology rampant in the policies imposed on many societies in Central and Eastern Europe since the early 1990s. Yet such remarks are confined to promoting the economic security of socially non-descript smallholding farmers. It is a veritable rarity to witness any awareness about the social identities of soil managers. Richter and Markewitz (2001, 3–7) and Lal et al. (2004) exhibit hints of sensitivity towards the gendered nature of soil use, for example, but this is confined to a series of photographs in the former and a flowchart entry in the latter, with no discussion on the subject.

Richter and Markewitz (2001, 11), contradicting managerialism by advocating for greater "technical understanding of how management alters soils over time,"[10] outline the history of soil use in what is now the south-eastern US. They show that Native Americans practiced sustainable soil use, compared to subsequent destructive practices by "early pioneers" or "settlers" that pushed cropland from the floodplains to the uplands, where low-CEC and low-pH (i.e., low fertility) soils abound (Ultisols, in USDA nomenclature). Such greater sensitivity to the effects of settler colonialism has counterparts in places like Australia, where "inappropriate land uses" are traced squarely to "settlement by Europeans" (Edwards 1993, 148, 153). This could be useful to decolonization struggles. The trouble is that authors from settler colonial regimes, like the US and Australia, fail to mention the genocide and mass forced displacements involved in what amounted to successive military invasions. Besides their insensitive use of terms (e.g., "settlement"), they treat Indigenous Peoples as homogenous and historically static. They do not describe what happened to Indigenous Peoples and their past and/or current impacts on soils. Nor do they show much interest in, for example, the rather different conditions faced historically by oppressed peoples within those countries relative to effects on land use. At least Richter and Markewitz (2001, 119) recognize that soil degradation in the southeastern US was associated with a "rural economy based on slavery," though wrongly assuming similar conditions for "white" and "black" family farms (p. 126). In light of this, the theory expressed by agricultural engineer Beasley decades ago remains unsurpassed within the technical soils literature. Even if offensively caricaturing Native Americans as "primitive" with "close ties" to the land, he acknowledged that Native Americans were forced out and identified the problem as being that "most white men . . . considered land as something to own for profit making only." These processes along with inappropriate soil-exposing cultivation techniques, copious (I would add militarily conquered) arable land, and ever larger machinery are cited as the main contributors to "the highest rate of destruction of the largest area of productive soil in the history of man" (Beasley 1972, 6). However, the solutions sought are caged in the bourgeois institutional context the author inhabits. As other technocrats and bourgeois environmentalists, he resorts to using a generic first person plural as the subject that must change so as to achieve environmental preservation. How self-transformation is to be achieved is wrapped in mystery.

The above-discussed relative divergence from civilizationism (catastrophism), populationism, and managerialism demonstrates the repeated failure by soil scientists to develop credible explanations of soil degradation. This is because they do not seriously consider the social relations that compel one or another kind of soil use and impact. Pretending that soil degradation is a technical issue is mere fig leaf for avoiding the crucial task of educating oneself in social theory and the study of social processes. There continues to be a lack of rigorous study of social dynamics commensurate with detailed soils research. More specifically, by ignoring the relations of domination behind soil management differentials, soil scientists cannot explain differences relative to impacts on soils and accordingly tend to reinforce sometimes contradictory ideologies emanating from diverse sectors of government and business. All this matters not only in explaining how soils change, but also in formulating alternatives to counter practices that lead to soil degradation. Since social relations largely determine management practices, it makes little sense to repackage old technocratic approaches, whereby the culprit is already known (population growth, local mismanagement, bad policies) and soils data are gathered and interpreted mostly to fulfil the rulers' requirements of the day, masked behind bourgeois democracy and its national and international institutions (the NRCS, the European Commission, the FAO, the Global Environment Facility, etc.). Treating instances of soil degradation and scales of action (e.g., local, national, global) as discrete units, blaming the least empowered for causing soil degradation, concentrating on the relative merits of government policy, or obsessing over private ownership are ways soil scientists are complicit in rendering the enormous soil-destroying hand of capital invisible.

CHAPTER 6

LEFTIST ALTERNATIVES AND FAILURES

Among the early movements struggling against what would eventually be known as capitalism, the Diggers, a small group that sprung up in late 1640s England, took issue with the imposition of private property. They started to farm on common land in various areas of the country in 1649, of which the commune in Cobham (ca. 60 km southwest of London) is best known. Harassed by local landlords and the Cromwell dictatorship, they disbanded by the early 1650s, but left an inspiring legacy. One of the more prominent figures of the small movement, Jerrard Winstanley, was to write in a 1652 pamphlet ("The Law of Freedom in a Platform"):

> True *Freedom* lies where a man receives his nourishment and preservation, and that is in the use of the Earth: For as Man is compounded of the four Materials of the Creation, *Fire*, *Water*, *Earth*, and *Ayr*; so is he preserved by the compounded bodies of these four, which are the fruits of the Earth, and he cannot live without them.
>
> (Jerrard Winstanley; in Sabine 1965, 519)

Soils formed a pivotal focus of insurrection. There was little doubt that private property literally inflicts bodily harm (if not death), given that farming was the mainstay of food procurement in seventeenth-century England. Yet the Diggers' objectives were far from parochial. They reckoned that

> not only this Common [in George-Hill, Cobham, Surrey] . . . should be taken in and Manured by the People, but all the Commons and waste Ground in England, and in the whole World, shall be taken by the People in

> righteousness, not owning any Propriety [property]; but taking the Earth to be a Common Treasury, as it was first made for all.
>
> (Jerrard Winstanley 1649, "The True Levellers Standard," in Sabine 1965, 260)

The centrality of soil to world revolution would be largely diluted, if not removed in subsequent left anti-capitalist currents. In some ways, leftists mirrored the rest of capitalist society in their increasing remoteness from soils. However, Karl Marx focused on soils, not factories, in postulating the simultaneously social and environmental degradation brought about by capitalist production:

> Capitalist production . . . develops technology, and the combining together of various processes into a social whole, only by sapping the original sources of all wealth—the soil and the labourer.
>
> (Marx 1867, 475)

These are but a few examples of how soils have been appreciated as a basis of struggle in leftist movements and writings. Soils retain political importance in many parts of the world, wherever struggles over land are associated with growing or gathering food, including in the most industrialized of cities (Engel-Di Mauro 2012b; Heynen, Kurtz, and Trauger 2012). It is then curious how this attention to soils has never translated into any systematic effort to know what they are, how they work, how changes in their characteristics interrelate with changes in society. Those tasks have been left historically to biophysical scientists, whose worldviews are often infused with now reigning capitalist ideology, as discussed in the previous chapters.

This general lack of interest among leftists in explaining biophysical processes is in sharp contrast to the enriching debates and intellectual creativity on the theme of environmental degradation, how or whether it fits with leftist or critical ideas and movements, whether or in what ways social theories and/or leftist projects must shift their foundations, and whether or to what degree it is used for authoritarian ends (e.g., Benton 1989; Bookchin 1971; Forsyth 2008; Foster 1998; Haraway 1991; Harvey 1996; Hewitt 1983; Kovel 2002 Mies and Shiva 1993; Moore 2003; O'Connor 1988; Pepper 1993; Redclift and Benton 1994; Robbins 2004; Robertson et al. 1996; Salleh 1997; Schwartzman 1996; Smith, 1990; Swyngedouw 1996; Watts 1983; Wisner 1978). The plethora of writings and the range of topics are vast and the ideas debated stimulating, promising, and enlightening. Reference herein to those discussions is limited by my inability to account comprehensively for such voluminous literature, but also by the scope of this endeavor, which in this chapter is to summarize the accomplishments of leftists and critical scholars upon which the present work builds and subsequently the identification of problems in leftist theorizing traceable to a cursory or inadequate grasp of biophysical processes like soils.

CRITICAL AND LEFTIST CONTRIBUTIONS TO EXPLAINING SOIL DEGRADATION

Critiques of mainstream narratives about soil degradation have largely originated outside soil science, and they have even assisted in developing the framework for a broader perspective called political ecology. Some of these critiques were incorporated into the overviews and analyses provided in the previous chapters because they suited most closely the objectives of overhauling soils research, but they will be briefly revisited here to show continuity among the disparate works on the subject, as well as its under-appreciated richness.

Initial works questioning the mainstream environmental crisis narrative and highly populationist rhetoric came about by the late 1970s and early 1980s, with, for example, the work of Swift (1977, 1996) countering claims about desertification in the Sahel and of Beinart (1984) on racism and soil conservation in South Africa. There were also a few attempts within physical geography, as part of initiatives within the Union of Socialist Geographers, to break down disciplinary barriers and offer socialist perspectives on topics overwhelmed by technocratic approaches. One such work was by Bradley (1983), who exposed the biases against peasant farming in scientific irrigation research and soil surveys and outlined an alternative soil research program that focuses on local soil classification and understandings. Dahlberg and Blaikie (1999) have also shown the greater effectiveness of data-gathering and soils interpretation that takes seriously and compares multiple perspectives and priorities to arrive at conclusions about the status of soils. I have marginally contributed to refining this methodology by formulating and applying an approach that does not assume community or household homogeneity, focusing on gender-based difference (Engel-Di Mauro 1999, 2003). The community-oriented methodological approach has gained institutional support and has occasionally developed into guidelines broadened to a general land assessment and suited especially for agrarian, peasant communities (Stocking and Murnaghan 2000; Tengberg and Batta Torheim 2007).

There was therefore much ferment prior to the pioneering study on soil erosion and conservation by Piers Blaikie (1985). The importance of that volume is in providing a systematic and critical overview on the subject from explicitly leftist moorings. Drawing from contemporary Marxist perspectives, including world-systems and dependency theories, he concluded, among other things, that the very notion of soil erosion is debatable not only on technical but also on political grounds. Where soil erosion is a problem, conservation programs often fail as a result of ignoring the fact that soil erosion is also a question of social conditions. These are not confined to localities where soil erosion is alleged to be occurring, but involve linkages to worldwide political economic relations. He posits four ways of understanding soil erosion and conservation: (1) they emerge from social structures; (2) technical approaches are ill equipped to address these structures; (3) all conservation projects have ideological assumptions about social change; and (4) ideas of social change must have priority (Blaikie 1985, 149). Less appreciated is his development of a model of soil erosion linking modes of production to soil erosion and broadening the analysis beyond peasant societies to include large mechanized capitalist and state-socialist farming.

This germinal work was followed by a co-edited volume with Harold Brookfield where the "regional political ecology" approach was introduced, inspiring much work thereafter, some of it spinning away from any actual research on biophysical processes and certainly away from any concern with soils (Blaikie 1999; Walker 2005). The volume included an excellent piece by Michael Stocking, whose critiques of soil erosion estimation were included in Chapter 4. Other contributions included the linking of interactions and scale and an alternative concept and formula of net degradation (Blaikie and Brookfield 1987, 7, 14; Brookfield 2001, 174).

Other studies have since expanded on such political ecology frameworks and, more recently, in environmental history. Zimmerer's work in the Bolivian Andes demonstrates the influence of differing perceptions and effects of shifts in social relations on soil erosion rates and distribution (Zimmerer 1993, 1994). The inescapably social character of soil conservation has been forcefully demonstrated through detailed historical studies. These point to the inefficacy of soil conservation based on racist policies, as with British colonial dictatorship in Southern Africa (Beinart 1984; Delius and Schirmer 2000), but also to the importance of local social conditions and struggles in the outcomes of soil conservation policies even within the same general imperial formation, such as in St. Vincent (Grossman 1997). Kate

Showers, in continuity with Blaikie (1985), illustrates how soil erosion in Lesotho is inexplicable without putting Basotho land use change in the context of resistance to British-Dutch encroachment, warfare, and dictatorship (Showers 2005, 16–19). The study by Bell and Roberts (1991) of Dambo soil classification under and following colonial dictatorship in Rhodesia/Zimbabwe demonstrates, by example, a methodology for discerning the political processes behind technocratic knowledge production (cf. Bradley 1983).

The above studies attest to the importance of context specificity to explain soil degradation. Much research is dedicated to the racist and colonizing aspects of soil degradation and of soil degradation theories. Class-based analyses, regrettably, tend to be rare and probably because of the focus on peasant and pastoralist systems under colonial situations or under scrutiny and on intervention from international institutions. There have been, however, studies demonstrating the linkages between gender relations and soil use and degradation that would be useful towards refining existing ecofeminist work, which, like other leftist approaches, tends to overlook the analysis of biophysical processes. Although sparse, these case studies indicate that gender relations have implications for soil conditions and that, conversely, changes in soil quality affect farming community members differently according to gender (e.g., Gladwin 2012; Kamar 2001; Kunze, Waibel, and Runge-Metzger 1998; Oromo 1998; Reij, Scoones, and Toulmin 1996; Rocheleau, Thomas-Slayter, and Wangari 1996). For example, Carney's study in The Gambia attests to the importance of understanding gender-specific practices and knowledge when analyzing soil degradation. Rice irrigation has been traditionally women's work, but government projects involved the transfer of pump irrigation technologies mainly to men, resulting in the activation of acid-sulfate soils in some circumstance (Carney 1991). Leach and Fairhead (1995) show that, in Northern Liberia, women's subsistence production has promoted long-term soil fertility by raising soil OM. Yet such practices are entangled in historically shifting gendered resource control associated with increasing constraints on women. These findings concur with the results of my previous research in Hungary, where, though over a much more limited area, a local patriarchal system is associated with gender-differentiated soil classification and use and more sustainable practices among women (Engel-Di Mauro 2003). Overall, these and other findings demonstrate the importance of examining gender relations as part of a set of causal factors determining soil quality change and the spatial distribution of soil characteristics. Whether gender roles are enabling or constraining, a linkage exists between gender relations and environmental practices that affects or even induces soil quality change. The matter then becomes one of understanding at what conjunctures multiple social and biophysical processes give rise to soil degradation.

Many insights and innovative ways of explaining transformations of soils and questioning mainstream theories of soil degradation originate in research carried out in African contexts. The edited collection by Reij, Scoones, and Toulmin (1996) provides a wealth of examples of indigenous African systems of soil and water conservation, but it also demonstrates the fallacies of populationism and managerialism. The former is contradicted by the intensification of conservation measures with higher population density. Managerialistic explanations can likewise be rejected by pointing to the sheer existence and efficacy of conservation techniques that are developed without technocratic, or, rather, often because of a lack of technocratic intervention. There is no denial that conservation techniques and technologies have been adopted by indigenous Africans, but coercion, lack of sensitivity to internal differentiation within a local community, and adverse political economic conditions tend to undermine conservation efforts. Another edited collection (Scoones 2001) elaborates on the continuing scientific misrepresentation of the status of soils in Africa through survey-based data aggregation, experimental plots, and nutrient balance sheets. Such tendentious production of scientific knowledge that ignores the spatial diversity and temporal dynamics of soils serves to legitimate policy interventions that run roughshod over the social processes behind soil degradation, if such a problem is not an artefact of scientific constructs. A grasp of local agro-ecological and social conditions is therefore necessary to assess changes in soils and possible trajectories.

A more comprehensive view of soils tends to be rare, but an impressive environmental history collection edited by McNeill and Winiwarter (2006) contains numerous in-depth analyses of various regions of the world, showing a great variety of soil uses and human contributions to soil formation, such as on wetland soils throughout the Americas. Given the state of the evidence, some of the work is speculative. It is centered about soil erosion, with a few chapters devoted to nutrient cycles. Showers (2006), in a commendably thorough explication of the relationship between African peoples and soils, gives an appreciation of the immense history and variation of soils and human shaping of them, all of which tends to be whitewashed in crisis narratives to justify largely European colonial impositions in the past and now international interventions that have often destroyed more than conserved soils (cf. Leach and Mearns 1996). Among the studies is also an evaluation of long-term effects of practices by Indigenous Rapa Nui inhabitants and under the more recent European colonial regime (Mieth and Bork 2006). The authors point to enduring sheet erosion after deforestation followed, after colonial conquest, by a shift towards more gully or linear erosion with sheep herding and the final demise of endemic tree species. Overall, these studies implicitly question catastrophist notions of soil degradation and populationist explanations as well as provide evidence of often sharp contrasts in the degree of soil erosion between periods preceding and succeeding European colonialism and the eventual formation of national states.

As the above variety in approaches attests, the answer to the question of why human-induced soil degradation occurs must be found at a deeper level, beyond population growth, technological systems, property regimes and market quirks, and other such factors because they are outcomes, not drivers of social relations and of people–environment interactions. Soil degradation can be explained in many ways, but it necessitates investigations focused on social processes, from understanding causes of soil degradation to defining and classifying soils as degraded. Whenever such investigations are made, populationist and managerialist arguments have been proven false.

Accomplishments and Limits of Leftist and Critical Work on Soil Degradation

What is striking about both leftist and critical work on soil degradation is the overwhelming concentration on erosion and, to a lesser degree, nutrient cycles (fertility), and a progressive, nearly total disappearance of any outwardly leftist political commitment. Save for occasional and generic remarks on OM and pH, there has been, to my knowledge, virtually no attention to soil biology, chemical processes, and many physical properties, like structure and hydraulic conductivity. Most studies have been largely reactive, addressing the biases in established, institutional knowledge, but germinal alternative frameworks have nonetheless been developed that can serve more proactive objectives, even if not explicitly addressing egalitarian concerns.

With respect to social processes, the dearth of class analysis looms large and so does the exiguous attention to international linkages and processes that affect soil use (Engel-Di Mauro 2009, 2012a). There has been a tendency to treat the occurrence of soil degradation as an isolated process, when actually occurring, and as part of an international process, when partially an artefact of official renditions by governments or supra-national entities. Moreover, since Blaikie's initial attempts, no general theory of soil degradation under capitalist conditions has been proposed, nor any systematic comparative analysis.

Nevertheless, major strides have been made in reaching institutions, not just with respect to academic theorization. Some of the above-described work, perhaps because adopting more politically innocuous critical frameworks, has reached the academic mainstream and institutions like the World Bank, the FAO, and the Global Environment Facility (Blaikie et al. 1995; Tengberg and Batta Torheim 2007). They have even featured in relatively widely read periodicals like *Science* (Stocking 2003) and *National Geographic* (Mann 2008, 96–100). However, they have been either ignored or wildly distorted in soil science. Oldeman, Hakkeling, and Sombroek (1990, 18) translate social questions to mean the "kind of physical human intervention" causing soil degradation. Gerrard's high esteem for Blaikie and Brookfield as "authorities" goes little further than the platitude of describing soil degradation as a "major world environmental issue" (Gerrard 2000, 177). For Oldeman (2002, 2) social criteria are equivalent to a vague "human dimension," never seriously addressed. The sometimes cited Blaikie and Brookfield's "regional political ecology," for example, has had virtually no impact on soil science as a result of gross misrepresentation (Boardman 2006, 74; Chen et al. 2002, 244; Safriel 2007, 2; see also Chapter 4).

It seems that eliminating straightforward expressions of revolutionary commitment is mostly ineffective if the goal is to shape soil science or change institutional policy frameworks. More importantly, relative to overall political arrangements and struggles, the influence of these leftist efforts has been even more meagre. Nevertheless, they remain worthwhile for at least three reasons. One is in diffusing the perspectives of many people with exiguous political power who rely on soils for livelihood. Their understandings (and mine) can clash with official or even some leftist activist pronouncements, such as in the relative importance of soil erosion or the very concept of soil degradation (e.g., Bayliss-Smith 1991, 6; Brookfield 2001, 158–161; Sillitoe 1993). While it is true that this kind of endeavour is fraught with pitfalls of misrepresentation and risks of silencing while amplifying, one must also weigh it all against prevailing institutional populationism and managerialism. This connects to another reason, which is to counter not only capitalist propaganda in the mainstream, but also misconceptions among leftists. Finally, combining soils research with leftist perspectives is important for the development of alternative research programs, funding priorities, educational curricula, and technical outreach.

A CRITIQUE OF MOST LEFTIST APPROACHES

Ostensibly leftist scholarship on soil degradation has been limited and even critical frameworks have had limited impact, but they have at least addressed what the vast majority of leftists do not or, worse, surmise they adequately cover. As Engels put it, in his preface to *Anti-Düring*, "knowledge of mathematics and natural science is essential to a conception of nature which is dialectical and at the same time materialist."[1] Leftists may be justifiably wary of these sciences, but shying away from them or merely critiquing them from the outside results in faulty political projects. If, as David Harvey (1996, 196) well put it, socialists are to "know best how to engage in environmental-ecological transformations" for socialist ends, it is astonishing how still so little leftist work concentrates on creating the necessary knowledge for such transformations (cf. Johnston 1989). As David Schwartzman has forcefully pointed out:

> . . . socialist theory has long lacked a full conceptualization of the technological basis of an ecosocialist transition to a future global society . . . . Socialist or Marxist political economy cannot theorize this transition by itself. The natural, physical and informational sciences . . . must be fully engaged. These sciences will inform the technologies of renewable energy, green production, and agroecologies, whose infrastructure are to replace the present unsustainable mode. Marx and Engels had prophetic insights into the ecological impacts of capitalist society. But there has been little socialist engagement with the physical and natural sciences necessary for a sustainable economy . . . The near absence of ecosocialist theory and practice has left a space for the penetration of Neo-Malthusian and "end of growth" ideologies into the contemporary green movement. We are treated to continual invocations of fallacious visions of entropic apocalypse, leading to the die-off of civilization.
>
> (Schwartzman 2009, 11–12)

While a dialectical materialist approach or an ecosocialist future may not conceptually or politically find agreement with everyone on the left, an alternative egalitarian society cannot sprout solely by theorizing and altering social relations. And one outcome of this failure to grapple with biophysical processes is an inadequate understanding of environmental degradation in the theorizations of some leftists (see Chapter 4), some of whom even adhere to such reactionary notions as civilizationism and populationism (see Chapter 5; Harvey 1996, 191–197).

The problem is not so much a failure to reach out to other sciences, as much as the tendency for most leftist scholarship on environmental degradation to refrain from active involvement (Peet, Robbins, and Watts 2011, 10, 31) or to be disconnected from leftists' and critical scholars' research on biophysical processes, if not the biophysical sciences altogether. Much more is needed than translation or unifying language (Harvey 1996, 190) to reach scientific unity. A concerted effort is necessary among all concerned to surmount the lack of a common political project among leftists, the prevalence of reactionary or capitalism-accommodating views among academics, and powerful institutional forces that divide scientists as workers.

Nevertheless, even if still rare, there is leftist and critical scholarship that has undertaken the task of parsing through scientific works on soils if not contributing to producing soil knowledge directly. Such work has also been done in the case of primatology with the work of Donna Haraway, for example, and evolutionary biology, with the work of Stephen J. Gould, Richard Levins, and Richard Lewontin. It is thanks to these efforts that it has even been conceivable to carry out the present endeavor. None of this discounts the importance of leftist research that shows the social and often socially oppressive basis of environmental issues (or nature). But it is inadequate towards explaining the environmental processes involved and it is patently ineffective in moving the biophysical sciences in a more sensible direction or, if one prefers, building an alternative to "western science." It is striking how the bulk of leftist scholarship on environment remains fixated on addressing the social relations inhering concepts of nature or environmental impacts without much research into biophysical processes, even while discussing them. It is a most politically (including educationally) debilitating state of affairs rampant in the various ecofeminist, social ecology, socionature, production of nature, political ecology, and other openly committed leftist approaches. This institutionally rewarded narrowness at times makes for an exercise in reducing the ecological to a social appendage,[2] with nonhuman entities the ruse, passive backdrop, or undifferentiated actor.

It is a most welcome sign that "nonhuman agency" is being taken more seriously and without reproducing the environmental determinism of yore. This would already make for a much more encompassing approach to soil dynamics. For instance, Allison, Wallenstein, and Bradford (2010) find that carbon dioxide emission levels from soils may hinge on microbial activity responses to temperature increases.

Johnson (2012) reports that, in a region of California, rodents have been primarily involved in obliterating the effects of decades of industrialized farming on soil structure, within 40 years after farming ceased in the 1980s. These studies show that even in industrialized settings human impact is not the sole force in shaping soils or even climate change. Concepts like socionatures or produced natures, by overestimating the effects of social relations, provide unnecessary obstacles to explaining soil and other environmental dynamics. Yet much of the work on nonhuman agency, like the rodent and microbes case studies, concentrates on organisms, especially nonhuman animals (e.g., Haraway 1991; Urbanik 2012), which suggests a difficulty with incorporating other processes analytically (e.g., air movement, cation exchange in soils, ocean currents). The insistence on agency (or a narrow understanding of nature-transforming labor) might be a principal impediment, notwithstanding attempts by actor-network theorists to by-pass the problem through acrobatic sleights of hand (see below).

In spite of recent efforts, the recrudescent interest in the nonhuman remains as superficial on biophysical processes as soil scientists on social processes. Part of the problem is the lack of direct or active involvement in producing knowledge on biophysical processes, which results in reliance on technical experts' interpretations about nonhuman beings and forces. As demonstrated in the preceding chapters, ideological constructs can obfuscate findings. Some examples have already been pointed out in earlier chapters of uncritical borrowings from soil scientists regarding the extent and severity of soil degradation and the pernicious civilizationism and populationism, adopted by some eco-Marxists and world-systems theorists (Chapter 5). To plow through the obfuscation, there has to be careful analysis and reinterpretation of data on biophysical, not just social processes. Accomplishing this requires knowledgeable reading and a greater diversification of (updated) sources than usually appreciated. Thus, soil quality indicators and soil erosion data can be very useful information if reinterpreted relative to context and methodological limitations, rather than taken as a set of transferable findings or data to suit, say, political ecology purposes. Because too often leftist discussions are inadequately informed about the subject matter, rather than offer alternatives or insights, leftists at times fortify stereotypes or develop arguments of doubtful validity.

It helps little when errors are made about describing environmental degradation problems, like treating ozone layer depletion as a cause of climate change (Mies and Shiva 1993, 277). There is also a tendency to succumb to "popular imagination" (as do Peet, Robbins, and Watts 2011, 13) by subordinating environmental issues to climate change. The otherwise laudable undertaking by Chris Williams (2010) to demonstrate the ineluctably destructive nature of capitalism is representative of this reductionism. Williams is so focused on climate change (with a full chapter dedicated to the topic) as to lose sight of the inter-relationship of different forms of environmental degradation and the mutually constitutive changes involved in society–environment relations. It plays into a compartmentalized understanding of environmental change that stifles the forging of connections and imagining alternative political alliances. It is not that soil degradation should necessarily gain more attention in such leftist works. The fundamental problem is the inadequate study of environmental processes and the treatment of ecological processes as separable units or as nested hierarchy (with climate at the top), which forecloses the possibility of seeing politically consequential ecological connectivity and, ironically, converges with and thereby bolsters bourgeois understandings of the environment. For instance, soils happen to play a key role in planetary greenhouse gas biogeochemical cycling, yet there is no mention of soils in Williams' chapter on climate change. Here is a missed opportunity to draw together land struggles (which usually imply changes in land use) and greenhouse gas emissions, which points to the interconnections of environmental impacts from different fractions of capital (landed and industrial/extractive). Moreover, this could have been an occasion to demonstrate how much worse the repercussions are than even climatologists expected when permafrost regions warm up and greenhouse gases stored in soils are released into the atmosphere. These are examples of what leftists miss when they fail to analyze or study biophysical processes beyond social relations. But the problem is regrettably even more profound. It consists of denying equal importance to technical perspectives even while paradoxically relying on them to explain and organize politically about environmental degradation in the struggle against capitalist relations of domination.

Social Theory Over-Reach and Exegetic Maneuvers

The above inadequacies are a result and manifestation of a deeper problem on the left: the appropriation of environmental issues for social theory applications or the reinterpretation of texts from renowned social theorists to search for insights about human-induced environmental change. These are forms of social reductionism camouflaged by theoretical lucubration. Thus, social theorists are being recast as ecologists or environmental scholars. Karl Marx is credited by some with ecological sensibility (Hughes 2000) if not a precocious and superior ecological approach (Burkett 1999; Foster 2000; Moore 2003). Even Fernand Braudel and Immanuel Wallerstein are being transmogrified into such attentive analysts of environmental change that their works are deemed precursors to what is now called environmental history (McMichael 2012, 139–145; Moore 2003). But ecologically aware political economy, history, or sociology is no (paleo)ecology, Quaternary studies, or climatology. For when it comes to the study of processes like climate change one relies not on Marx or Braudel or Wallerstein, but on climatologists. Thus, McMichael, in endeavoring to prove Braudel as keen environmental analyst, succeeds in demonstrating the opposite by pointing to paleoclimatologist Ruddiman to buttress claims about climate change. And it could scarcely be otherwise, given that Braudel's major insight about physical environments, that they are not fixed, adds nothing to basic and well-known geological principles established well before Braudel was even born. Similarly, Moore (2007, 136) shows Braudel's poor understanding of soils in the assertion that wheat production inevitably results in soil exhaustion, rather than any insight into soil dynamics.

Using social theory to comprehend biophysical processes also results in an impoverished epistemology. Foster (2013) claims, for instance, that a materialist approach involves "Studying natural conditions and limits," rather than processes, dynamics, thresholds, and complexity, as increasingly understood in some Marxist thought (e.g., Harvey 1996, 48–57) and the biophysical sciences (e.g., Johnston 1989; Schumm, Mosley, and Weaver 1987; Scoones 2001; Zimmerer and Young 1998). Such undialectical understanding of the "natural" as mere conditions and limits ironically converges with the thoughts of Foster's imagined arch-rival O'Connor (Foster 2002), who finds Marx insufficiently materialist but then reduces the rest of nature to static conditions of production, where capital can even "alter natural laws" (O'Connor 1998, 46). This is inconsistent with his recognition of the "autonomy of ecological and physical processes" (p. 37), but, then again, O'Connor never really examines how autonomous ecological and physical processes and changes interact with social ones in the analysis of the relationship between ecosystems and capitalist social relations. The issue is not so much an underlying society–nature "dualism" (Castree 2002), nor is it, as the paranoid Burkett (2006, 6–8) has it, a problem of O'Connor's "functionalist grafting approach" fatally conquering ecosocialists' minds, drawing them away from Marxism (and even from a dialogue with ecological economics, such is apparently the powerful lure of O'Connor). Dividing leftists into camps of more or less and lapsed Marxists is a poor excuse for avoiding the more challenging task of making sense of ecological processes, which tend to be used as mere decorative receptacle filled with a list of capitalist harms. The issue that should be brought to the fore is that O'Connor's second contradiction thesis, much like Foster's and Burkett's ecological Marxism, never examines change in environmental processes. Such approaches therefore cannot distinguish autonomous from human-induced environmental changes and instead appeal to unsupported natural equilibrium arguments. Much of the misconception about biophysical processes is traceable to repeating the mistakes of Marx and Engels (see below) and ignoring the path they showed, and underlined by Foster himself, of keeping up with the biophysical sciences.

For similar reasons, McMichael's version of climate change, as that of many leftists, is flawed. Instead of discussing the complexity of atmospheric chemistry and global climate models, among other pertinent issues, he reduces the interplay between greenhouse gas emissions and atmospheric effects to a matter of CO_2 levels and human action, ignoring other terrestrial and extra-terrestrial factors[3] (see also Tanuro 2012). The superficial treatment of environmental dynamics is also painfully evident in McMichael's sole focus on climate, which appears as the only force of environmental change, as it apparently did for Braudel, our suddenly environmental historian. There is climate and the rest is some vague "environment." This is all the more curious because McMichael, in the same manuscript, shows awareness of other climate-altering physical processes within and outside this planet. It appears that intellectual inertia, manifested through overwhelming emphasis on the social and on white male social theorists (who, for example, tend to overlook or underplay social reproduction), is having the better of otherwise very sharp minds. The current vogue of drawing insights from social theory about people–environment relations not only implies that the characteristics of environmental processes can be subsumed under or can be treated in the same manner as social processes, but also results in sometimes outright incorrect and politically counterproductive arguments.

Metabolics

To illustrate the problem, consider the recent focus on the presumably ecological content of Marx's writings. Foster (1999) has painstakingly codified this as a thesis of metabolic rift, an exegetic interpretation that is blazing through many leftist minds (e.g., Clausen and Clark 2005; McClintock 2010; McMichael 2008; Salleh 2010; Williams 2010). To summarize, Marx's ecological thesis is that the capitalist mode of production entails a disruption (rift) in biophysical cycles or processes, a rift in the exchange of materials between society and the rest of nature (metabolism), resulting in a combined accumulation and depletion of materials respectively resulting in toxicity (waste) and degradation. Foster's efforts are commendable in showing that Marx's overall theoretical framework and insights are crucial to explaining the destructive tendencies of capitalist social relations (see also Burkett 1999; Kovel 1995). And Foster's contributions are important, as those of many others, in countering the typically dismissive attitudes about Marx's work in activist and academic settings, not just on matters of environmental degradation.

But the metabolic rift thesis makes of Marx not an ecologist, but a shallow non-dialectical thinker. Marx studied neither the relationship between people and environment, nor any biophysical process. Foster (2000) extrapolates the ecological in Marx from brief and vague excursions in texts addressing subjects other than ecological dynamics. In fact, it was much more Engels than Marx who wrote about the rest of nature, but Engels was mainly concerned, as evident in his unfinished *Dialectics of Nature* (1883), with developing a dialectical approach for all the sciences, not a study of ecosystems or of society–environment relations. Marx's primary concerns and far-reaching contributions were not about ecology, but about identifying and critiquing the foundations of a capitalist mode of production and contributing to a struggle for a communist society, besides formulating an approach to explaining social relations and change (cf. O'Connor 1998, 43; Tanuro 2010).

It is certainly the case that Marx and Engels exhibited concern about environmental degradation and took seriously the relationship between people and the rest of nature, and so did others during the nineteenth century, like the naturalist George Perkins Marsh and the anarchists Elisée Reclus and Pyotr Kropotkin. But Marx (or Engels), in contrast to these other authors, did not carry out any study on human impacts. Instead, Marx was focused on social processes even when arguing that the "writing of history must always set out from . . . natural bases and their modification . . . through the action of men" (Marx 1845, 149). His approach has no emphasis on studying the rest of nature and its histories, which is fundamental to understanding people–environment relations. There is no development of a dialectical approach relating environmental to social histories. To claim that ecology was central to Marx's work is to beckon the question of why Marx did not formulate general theories on, say, human impacts on soil development, if he was so concerned with soil depletion, one of the main examples used to demonstrate Marx's metabolic rift approach. The reason for such missing theorization is that Marx broached topics on nonhuman processes to explain one or another aspect of a social, not ecological process. The nonhuman component of ecosystems was never seriously considered. Or, stated differently, Marx can only be regarded as having ecological understandings if one treats ecology as reducible to what concerns social dynamics, a notion of ecology that makes interactions not involving humans inconceivable and diminishes the universe to the dynamics of parts of a single (human) species with whatever part of the environment they happen to impact or rely on.

It is not solely on exegetic grounds that Foster's thesis is objectionable. Moore (2011a) is justified in alerting us of a lurking Cartesianism, whereby social relations and the rest of nature remain apart in the process of material exchange (cf. Castree 2002). Yet the problem with metabolic riftism is even deeper. As Harvey noted some time ago,

> Cartesian thinking has a hard time coping with change and process except in terms of comparative statics, cause and effect feedback loops, or the linearities built into examination of experimentally determined and mechanically specified rates of change.
>
> (Harvey 1996, 62)

Metabolic rift describes and fixates on an outcome of capitalist human impacts, rather than a process or change. Hence, the issue becomes one of repairing rifts, instead of grasping the largely destructive transformation of ecosystems as a mutually constitutive process. This is a dialectical process, one that cannot be socially foreclosed because environmental change depends also on what happens in the rest of nature, not just in society. The repercussion in practice is the delusion that the end of the capitalist mode of production leads to a return to some lost stability and harmonious relationship with the rest of nature (Loftus 2012, 31–32), the obverse of the (human-free) museum version of nature still promoted by many of the Greens Foster (2000) loathes. Foster is thereby turning Marx into a thinker who, when it comes to people's relationship to the rest of nature, suddenly lost his dialectical way. In fact, this may very well be the case. Marx's explication of environmental change (e.g., soil depletion, metabolism) was derived by borrowing uncritically from some contemporary reductionistic scientists for the purpose of argumentative expediency in responding to reactionary approaches like that of Malthus.

It should anyway not be surprising to find inconsistencies and errors in any thinker. Tanuro (2010) has demonstrated the ecological fallacy in Marx's and Engels' lack of differentiation between renewable (e.g., wood) and non-renewable (e.g., coal) energy sources, as well as the authoritarian political ramifications of following such logic. Schneider and McMichael (2010, 468–469) point out that Marx erred in his simplified rendition of farming as a nutrient flux involving human-based manure and grain harvest and export.

Yet Marx's approach to biophysical processes was more deeply flawed than this. In agricultural chemistry, at the time, soils were viewed largely as passive, nutrient containers made of weathered-rock material, a view sometimes reconstituted currently under nutrient budget analysis (e.g., Scoones 2001, 11). Marx accordingly treated soils as masses of inert nutrient repositories (see also Merchant 1980), sometimes as if spatially homogenous, in spite of knowing better. In remarking on the deeply destructive nature of the British invasion of India, Marx (1853, 34–35) explained the contemporary "barren and desert" landscape of "Hindustan" as the result of "the neglect of irrigation and drainage" (an "artificial fertilization of the soil") otherwise provided through a central authority. It was not until the 1900s that soil and ecosystem variability in that "barren and desert landscape" was scientifically appreciated.[4] To Marx, soils in themselves were also static ahistorical entities, where "Capitalist production . . . hinders the operation of the eternal natural condition for the lasting fertility of the soil" (Marx 1867, 505). Later in life, returning repeatedly to soil in discussing ground rent, he recognizes that there are different soil types relative to fertility, texture, topography, drainage, and topsoil depth (Marx 1894, 879–880). But soil "natural fertility" is subordinated to conventional notions of agricultural productivity (see Chapter 3) and equated with "chemical composition," reduced largely to "the amount of nutrient elements for plants," a condition pliable by means of the application of chemical (e.g., fertilizer additions) and mechanical (e.g., deep plowing) techniques (ibid., 790–791). This conceptualization is what enables him to state, in comparing factories to fields, that the "earth . . . continuously improves, as long as it is treated correctly." Soils, viewed as inert "inorganic nature" (ibid., 954), are deemed unchanging without human intervention. Corresponding with Vera Zasulich in his final years, in a wider and enlightening discussion on Russian peasants' revolutionary potential, Marx (1881) suddenly forgets his appreciation for soil variability when he remarks how the "physical lie of the land in Russia invites agricultural exploitation with the aid of machines, organized on a vast scale and managed by cooperative labour." Just because land is flat, it does not necessarily mean mechanical cultivation is feasible or desirable. Soil texture distribution, for example, can affect the outcome of mechanized farming, and often the result has been what Marx could not have realized at the time, soil physical degradation through compaction. If we were to follow Marx (i.e., nineteenth-century agricultural chemistry) to develop an ecological approach, it would likely mimic that of an unreformed US Army Corps of Engineers. Marx could not have suddenly forgotten what he knew about soil variability if ecological processes had been central to his life endeavors.

Those wishing to convert Marx into an ecologist are confusing Marx's use of largely illustrative people–environment analysis (to show the fatuity of Ricardo's and Malthus' ideas) for a cogent theory on ecological relations. It is a decontextualized reading of Marx that does not dare ask the obvious, which is why Marx did not formulate a dialectical explanation of soil–society relations or, rather, why his dialectical approach ran short when it came to explaining soil quality change. This cannot be explained away by a lack of empirical evidence available during his lifetime. Anthropogenic organic inputs contributed to long-term accumulation of nutrients (see Chapter 2)[5] and ecologically sustainable practices could rest on nutrient imbalances, as with shifting cultivation. Hence, sustained or short-term rifts in material flows, whether cumulative or depleting, were not confined to capitalist practices. The issue is one of degree and multiple interacting factors, not rift. Marx could not have grasped this because he did not himself study the subject and relied instead on others' non-dialectical interpretations and research agendas, which precluded the possibility of examining agricultural practices that did not conform to the requirements of commercial farming (there is, in this, a still ignored consequence of settler colonial prejudice in the development of soil science; see Chapters 2 and 3). Marx was conversant with the publications of Anderson, Liebig, Johnston, and Carey (Foster and Magdoff 2000), but was apparently unaware of the works (in German, no less) of Senft (1857) and Fallou (1862) about soils as separate phenomena with their own spatially variable characteristics and historical development (formation from parent materials). If Marx would have read Fallou, for example, he might have arrived at different, less socially deterministic conclusions about soil characteristics.

It was anyway not until 1870 in Russia, with Dokuchaev and Sibirtsev, that institutional backing was secured to establish soil science as an independent scientific field. The first extensive and systematic study of soils was not available until 1883 (the year of Marx's passing), with Dokuchaev's internationally influential publication of the study of chernozems in Russia (Hartemink 2010). Darwin's only more recently appreciated study of earthworms, which demonstrated the organic and living aspects of soils, was not published until 1881.

Marx's notions of soils as inert, inorganic, malleable chemical input–output boxes, without history or dynamic of their own, stand in contrast to his dialectical approach. There is no study offered in Marx whereby social relations and soil dynamics are mutually constitutive. Soil characteristics are simply taken as given entities shaped by differing forms of human activity. This shallow treatment of soils should warn against extrapolating ecological concepts from Marx. If one expects Marx to have been a theoretician of metabolic rift, one could then ironically fault Marx for promoting metabolic rift (e.g., indifference to soil variability, treating soils as inert things). This, of course, is as illogical as extruding a theory out of inchoate and scattered concepts. Making Marx to be what he could not be impoverishes and diverts attention from Marx's profound contributions, especially in understanding the workings of a capitalist mode of production.

To appreciate how and where Marx's work is crucial to explaining people–environment relations there needs to be clarity about what can be attributed to and learned from Marx. First, it should be obvious that Marx did not theorize metabolic rift or formulate any precursor to ecology, nor were those lines of inquiry central to his work. Marx wrote no volume elaborating on the topic. The notion of metabolic rift was part of using data on biophysical processes to bolster a critique of social, not ecological relations in a capitalist mode of production. Second—and consistent with Marx's objective of a scientific study of society (not ecosystems)—metabolism, understood as material exchange between society and environment, systematically excludes the importance of material exchanges not involving people. Third, by considering only human impact, the very basis for assessing human impact cannot be established (neither was this part of Marx's endeavors). There cannot be thereby any assessment of what is to be considered a regular range or pattern of environmental change (e.g., geogenic levels of heavy metals in soils or pre-industrialization greenhouse gases in the troposphere). Global climate variations or landform degradation or soil erosion before humans existed or in the absence of human impact simply cannot be explained, as there are no exchanges of materials between society and "nature," nor, therefore, any rifts.

Refuting the metabolic rift thesis detracts nothing from the importance of Marx's contributions or even from Foster's and other Ecological Marxists' insight, shared with some other leftist approaches (ecofeminist, ecosocialist, eco-anarchist), that the capitalist mode of production is inherently destructive ecologically (cf. Johnston 1989, 199). If anything, by resisting contrived readings and inappropriate applications of concepts, the rejection of the metabolic rift thesis enables the highlighting of those theoretical aspects in Marx that improve explanations of environmental degradation, like dialectics and materialism. As stated above, Marxists trying to develop ecological approaches should follow the example set by Marx and Engels themselves, who had a keen interest in and kept up with the most recent scientific research. And they did so precisely because they were not themselves studying or theorizing on those subjects, save occasionally for Engels (1878, 1883). In this light, developing a dialectical and historical materialist approach to science (e.g., Harvey 1996; Levins and Lewontin 1985), as Engels had begun to do, makes for a much farther-reaching and deeper contribution—and at the appropriate levels of abstraction—than forcing scattered peripheral remarks to converge into constituting a theoretical framework.

Homeostatics and Teleology

The manner of appropriating Marx's work in the metabolic rift thesis is also underlain by an assumption of preordained stability, reminiscent of notions of static equilibria and teleological theories in ecology (e.g., Clements' idea of climax community). Both presume that a balance will be restored once the capitalist mode of production ceases to exist, rather than viewing prospects for a new mode of production to involve global and regionally specific challenges resulting from past impacts (e.g., global warming, missing mountain tops, persistent organic pollutants in fluvial and ocean sediment) and the dialectical relationship between new forms of human impact and shifting interrelations among the myriad forces in the rest of nature, affected by and simultaneously independent of human intervention.

Homeostasis surfaces, disappointingly, even in leftist conceptualizations, particularly among activists. It is prevalent in anarchist theorizing, at times claimed to be inspired by Reclus and Kropotkin, but not developing any systematic approach that links social relations of domination and environmental change, save by presuming the former denies the harmony presumed in the latter (Pepper 1993; Purchase 1997). Within this framework sometimes reference is made to bioregionalism, whereby the world is made up of distinct regions as if no conflict existed among people regarding the extent of a bioregion and the criteria to define it. It also cannot cope with resource-procurement systems (e.g., pastoralism, shifting cultivation, seafaring) involving migrations across a wide range of environments. Kropotkin's approach is similarly teleological, using what he called a "kinetic" inductive-deductive natural science approach that was expressly anti-dialectical (Kropotkin 1903, 38–39). For him, changes emerge from both external pressures and internal contradictions between mutualistic and competitive tendencies, bringing about tensions or crises leading to new evolving forms of mutual aid (Kropotkin 1902, 299). Social processes are read uncritically out of a universal and teleological broader nature in a Manichaean play of mutualism and individualistic competitiveness where inevitably mutualism emerges victorious, even if constantly reconfigured. Reclus would have likely interpreted society–environment relations more dialectically as human impact bringing temporary changes that transform a place into developing a new type of order (Clark 1997). This more dynamic understanding has yet to be refined or challenged or applied towards explaining environmental degradation (aside from generalities about people being in or out of tune with an ecosystem).

Explanations of long-term or planetary social and ecological change in world-systems theory fall into possibly more egregious harmony quagmires. Chew (2005, 57) argues that "dark ages" (social systemic crises) enable the restoration of an undefined "ecological balance" and attempts to compare the time-scales of social and ecological change, blissful of the vast heterogeneity in physical and ecological processes, which are all made into a mass of undifferentiated "ecological time." A systems-oriented collection edited by Hornborg and Crumley (2007) is replete with functionalistic arguments where social change is environmental adaptation and with tendencies to treat societies as a single, internally indistinct entity (this can also be traceable to inadequate data resolution in the archaeological record). Sometimes, factors like climate change and empirically unsupported demographics are attributed with causal powers over society with the banner of environmental determinism at times unabashedly waved. For instance, Meggers insists on environmental conditions constraining social development in the Amazon Basin's shifting as a result of presumably nutrient-poor soils. There are also too many assumptions about civilization that are little different from what was critiqued in Chapter 5, such as Alfred Crosby's chapter. In all this, soil features (if it features at all) as the receiving end of impact, mainly in terms of erosion and presumed soil nutrient content, without any attempt to analyze changes in soils and their effects on later society–environment developments. Worse, Meggers assumes nutrient content as unchanging and completely ignores Indigenous Peoples soil management relative to nutrient cycling (e.g., Hecht and Posey 1989), while Berglund presumes erosion to be traceable to farming without any comparative analysis of soils in farmed areas with the sedimentary evidence (e.g., lake varves).

Nevertheless, the volume contains some interesting reflections on ecological and social dynamics, aside from some useful empirical studies. One debunks the idea of environmental degradation on small islands resulting from solely local human impacts (rather, it is incorporation into the capitalist world-system that generates such fatal tendencies). Another further corroborates empirically the already known lopsided flow of resources from the world-system periphery to the core. The more theoretically promising works are those developing recursive models of social and ecological change (e.g., Berglund 2007). Ecological shifts are associated with social changes that become cumulative, such that successive ecological change is met with a different sort of human impact. Regrettably, there is no attempt to address how human impact induces ecological shifts that affect subsequent ecological change (except Emilio Moran's rather speculative thesis of global climate change affected by land use change in antiquity) and one is left with a notion that departs little from the usual narratives of technological stages where the social relations that give rise to technological change are unexamined. That sort of understanding assumes that when a technology is developed it will necessarily be used to increase resource extraction. Focusing on changes in form and degree of environmental impact relative to varying technological complexes would help resist this pervasive capitalist view of technology.

In contrast to such relatively more dynamic modelling of the past (cf. Moore 2011b, 132), claims of metabolic rift as uniquely capitalist phenomena are predicated on assuming ecological balance. They imply a relative harmony between people and ecosystems before capitalism (Rudy 2001, 58), an argument discredited by findings of non-equilibrium dynamics (Grabbatin and Rossi 2012) and undermined by historical examples of non-capitalist environmental degradation furnished by Foster (1994).[6] The metabolic rift thesis in particular, just like Chew's "ecological time," unravels when applied to actually existing ecological processes. In soil acidification, for instance, three processes co-occur at differing rates that do not necessarily balance (Helyar and Porter 1989; Sparks 2003). One is what happens in soil water (seasonal to annual change), one is what happens at the interface between soil water and soil particles (from nanoseconds to seasonal variation, to secular trends), and another is what happens within soil particles (secular to millennial trends/cycles). With multiple simultaneous processes at varying temporal scales, it is not possible to make a case for metabolism, a balanced material exchange (e.g., between people and environment). Human inputs (some substance or impact) have no necessarily commensurate output (the transformation of a substance or degradation). In fact, an acidifying input, such as synthetic nitrogen fertilizers, may result in an insignificant output (little to no acidification), if not possibly the opposite outcome, if lowering pH in an alkaline soil enhances breakdown and nutrient release. Such imbalances in material exchanges cannot exist according to metabolic rift theory. Moreover, soil acidification, in environments where it rains frequently, is a regular trend, with or without human impact (Sumner and Noble 2003), so conceptualizing such an ecosystem according to metabolism runs counter to the evidence of an inherent imbalance of material exchange (e.g., hydrogen cations or protons added through rainfall leading eventually to decreasing pH, the rate and even direction of pH change depending on soil buffering capacity and other variables that can also change over time).

The issue should rather be whether and how human impact accelerates biophysical process (this is not a linear process, as liming, manuring, etc. can counteract acidification sometimes for decades) and, crucially, this is not reducible to a mode of production because other organisms and also physical processes (which may or may not be impacted by people's activities) are involved. Some of the biophysical processes have nothing to do with a mode of production because they have occurred before the existence of that mode of production. So, for example, over the same area, there may be soils whose mineralogy is such that they are more resistant to acidification than other nearby soils. The effects of human impact from the same mode of production will then have different outcomes (one soil acidifies fast, the other does not acidify much at all) because of differences in soil mineralogy, a process that takes millennia. This is all beyond the explanatory framework of metabolic rift and yet it is essential in explaining changes in soils. The metabolic rift, treadmill of production and other like theories are premised on as erroneous an understanding of environmental change as that presented by Montgomery (2007b), where geological erosion rates never result in soils disappearing (see Chapter 4).

It shares with mainstream soil science (cf. Lal et al. 2004) and wider bourgeois environmentalist ideology the notion that only people cause environmental harm.

Capitalist World Ecology

Jason Moore (2011b), equally prolific a writer as Foster, has made impressive strides in reconceptualizing capitalist social relations to account for the ecological processes on which it, like any other social system, is based. In this, he is much ahead of most other social theory approaches. He seems, however, to be largely doing political ecology without the necessary detailed attention to actual biogeophysical processes present in at least some of those works (e.g., Carney 1991; Swyngedouw 2004; Turner 1998). The otherwise most welcome emphasis on the capitalist mode of production is actually similar to the work already done decades ago by Blaikie (1985), for example, but without the caution. The main difference with political ecology seems then to be in the scale of analysis, the branding of the approach ("capitalist world ecology"), the elision of socially reproductive processes (while claiming otherwise), and the inadequate ecological analysis, among other problems (Moore 2003, 2010b, 4–5, 2011a). Aside for the complete disregard for, among others, feminist theories and scholarship, some of the weaknesses in the approach stem from Moore's use of limited or unreliable paleoecological data and reliance on social theorists and environmental historians to carry out analyses that require biophysical research (see below).

But the trouble is epistemological. Capital is the sole protagonist and capitalist productivity is adopted as the standard to evaluate everything and everyone. This is evident in Moore's concept of capitalist global ecological relations and in the commodity frontier thesis of capitalist expansion induced by "ecological exhaustion" (i.e., both social and nonhuman).[7] In this thesis, capitalist expansion is putatively propelled by capitalism-induced "scarcities [that] emerged through the intertwining of resistances from labouring classes, biophysical shifts, capital flows and market flux" (Moore 2010b, 39). The concept and thesis exaggerate the social (the part) over the ecological (the whole) and, in a reinforcement of settler colonial fantasies, make of social struggles and nonhuman processes mere residuals of capitalists' active shaping of the world. The commodity frontier thesis is about human labor productivity (Moore 2010a), only peripherally about ecological dynamics, which end up as carpeting for capitalist treading pleasures. Anti-colonial struggles, continuing to this day, become mere resistance, not active shaping of the world, and they disappear entirely when "ecological exhaustion" has been reached. The Tecumseh rebellion ("labouring classes"?), for instance, has no role in the "scarcity" created by capital. Or imagine capitalist sand grains, pine trees, earthquakes, squirrels, and so on, all turning communist when a communist world emerges. The commodity frontier thesis, furthermore, reduces ecological change to a capitalist underproduction problem (Moore 2011b, 110, 113), mimicking the mistakes made by O'Connor (1998) and Wallerstein (1999), among others. Very little is thereby revealed about what is being impacted where and how, which is what actually matters when it comes to livelihoods and survival. Rather than omitting, exaggerating, and diminishing, one could simply state, as many have done, that the capitalist mode of production is undermining the ecological conditions that favor human and many other organisms' existence.

There is also at bottom a lack of dialectical materialist understanding of historical society–environment or ecological processes. His otherwise compelling historical reinterpretations leave no room for ecological transformations that affect and are affected by social ones. For instance, climate change (Moore 2011b, 125) suddenly enters the picture as a historical variable (until then all of "nature" is treated as passive substrate with no influence on society), but is treated ahistorically by claiming an analogy between current global warming at the planetary scale with the Little Ice Age affecting "feudal Europe" in the fourteenth century. Europe is Earth and climate change is all of a piece, with respect to cause, effect, and characteristics. With such superficial analogy, there can be no historical materialist understanding of changes in society (e.g., capitalism-induced industrialization) contributing to accentuating global warming trends since the last glaciation and, in turn, how changes in atmospheric chemistry, brought about in part through social change from some societies, have been leading to changes in those societies themselves and in other societies relative to differential effects of weather extremes, regional aridification tendencies, environmental movements pressuring for technological and hence economic shifts, and so on.

Moore's interpretations of ecological processes also confine reality to the dynamics of current capitalist systems projected into the past, leaving no scope for any intertwining with other contemporary modes of production and their ecological impacts. Is one really to understand, for example, that wetland soils shaped by hundreds of years of Ojibwa land use make no difference to water resources used by capitalist European settler colonists? Is worldwide environmental degradation (which kind?) just a matter of capitalists constantly moving on to new "commodity frontiers" because of "scarcities differentially created by social resistances intertwined with ecological shifts and market flux" (Moore 2012, 69)? There lurk some basic empirical problems in this fable of "hit and run" capital leading to worldwide environmental degradation and a presumably final peak of world resources. For one thing, resource exhaustion is assumed, never proven, and ecosystems are treated as if mere containers (see below on soil exhaustion), rather than dynamic interrelations. This impoverished view of ecology also cannot explain, for instance, forest differential regeneration in formerly deforested areas and the development of large capitalist firms using resources from regions where apparently resources had been exhausted (e.g., Tyson Foods). The outcomes of resource extraction are not so simple or straightforward. One must reckon with ecosystem diversity, multifarious linkages between different societies and ecosystems, and social struggles impacting land use and technological change and applications, among other issues. Thus, the "world-ecological perspective" narrows, rather than "opens up the analysis of all forms of human experience to the interplay of human and biophysical natures" (Moore 2010b, 4). There is a long way yet to reach the level of ecological understanding Moore so ambitiously proposes and the answers are not forthcoming from pouring over social theory texts but from studying biophysical processes as well.

Repercussions of Social Theory Over-Reach

It is for eminently practical reasons that it is a futile effort to turn solely or mainly to social theorists to explain and act on environmental degradation, rather than learn critically from people with actual biophysical science expertise. Bluntly stated, it is emphatically not by using social theories that one can describe soils or develop a grasp of their function. Social theory approaches do not enable any identification or description of processes like erosion, microbial diversity, OM formation, or CEC, which are crucial to understanding soil degradation. So vague and coarse are such conceptual tools in social theory relative to environmental processes that they cannot distinguish such processes as mining from farming induced gully erosion. And yet being able to differentiate them ramifies into political strategy. Large mining concerns and more diffuse farming operations cannot be tackled in the same way. There is hence little prospect in social theory for explaining how capitalist practices impact soils without learning about soils themselves. There are also direct impacts to leftist politics from such social theory over-reach and misunderstandings of environmental processes. Eco-Marxist exegetics, for example, is emerging in leftist outlets like the Australian Green Left, where readers are informed that "Marx had a coherent approach to ecology, which emphasized the historically conditioned, co-evolution of nature and human society" (Butler 2013). The ecological insights coming out of such a coherent approach are certainly clear and clearly far from Marx.

SOIL MISADVENTURES IN LEFTIST NARRATIVES

In most leftist theories on the environment, the existence of soils is sometimes acknowledged, even exalted, sometimes even allowed a major role in a play, but not major enough for most leftists to be genuinely interested in what they are like, how they differ and connect with other processes, how they form or fall apart, how their characteristics develop and change. Soils (like the environment) often serve as social theoreticians' display models, to be summoned when convenient and just as readily removed from view when they no longer exhibit potential as explanatory expedient. But soils are like specters haunting theory, because once they are summoned, they can unleash all sorts of unwelcome surprises. Or, rather, those are the unexpected gifts that attentiveness to soil dynamics can impart, as witnessed in the above appraisals of some leftist approaches. And so it is that the more soils are expected to be the same, the more diverse they are, the more they are deemed exhausted, the more lively and fecund they become, the more their degradation is depoliticized, the more unruly and political the degradation turns. In short, the less one knows or thinks about them, the more insidious they become. An absence of soil or truly ecological analysis can derail leftist arguments towards dubious conclusions and lackluster politics.

Soils as All of a Piece

For all the ink consumed to express greater sensitivity towards nonhuman processes, biophysical processes like soils are still too often treated as indistinguishable, unchanging backdrops in the explanatory frameworks of leftist scholarship. There is a long illustrious history of negligence towards pedodiversity. It might not undermine entire theories, but it does reinforce some dangerously inaccurate mainstream notions and lessens the left's overall credibility in providing a workable alternative to the capitalist mode of production. In the above discussion, it was shown that Marx's appreciation for soil variability was inconsistent, in part because soils (or ecosystems generally) were not the focus of his studies. Yet the characterization of soils as homogenous substrates dies hard on the left and probably for similar reasons.

Carolyn Sachs, for instance, connects soil degradation to the gendered inequalities and androcentric expansion of capital, bringing increasing mechanization and intensification of land use, male monopolization of farming technologies, and marginalization of women's (often manual) work. The ensuing problems are differentially experienced according to gender, with women tending to be more negatively affected (Sachs 1996, 56–65). However, these claims rest on assuming differential changes in soils relative to impact to be irrelevant to social change and hence to patriarchal arrangements. No actual soil analysis is anyway provided in support of the theory.

One manifestation is in presupposing tropical soils to be fragile and infertile, a colonizer notion that has been refuted decades ago in the mainstream of soil science (Schaetzl and Anderson 2005, 388–392; Showers 2006). O'Connor (1998, 44) asserts that both farming and ranching have failed in Rondonia (Brazil) because tropical rainforest soils have been "disturbed." This stereotype of tropical soils is repeated in Foster (1994, 24). Meggers (2007, 196) misplaces her justifiable concern over current deforestation in Amazonia by insisting that soils in that region could not have sustained dense sedentary populations, thereby making the error of assuming not only soil homogeneity, but also, as Hornborg points out in the same volume, of completely isolated societies.[8] These views are contradicted by actually existing pedodiversity and centuries of soil-altering agriculture, including in Rondonia (Cochrane and Cochrane 2006), precluding the possibility of homogeneous effects on and of soils.

Bernstein and Woodhouse (2006, 150) reinforce the same misconception about tropical soils in Africa. A mere glance, say, at the *Soil Atlas of Africa* (Jones 2013), which is partially based on extrapolations from 1970s and more recent data, already reveals much soil diversity within the tropical forest zones even at such low resolution. The authors could be spared critique, given when the atlas was made available, but even the much older world soil atlas from the FAO[9] would have shown similar information. If the authors would have applied the same interpretive criteria to tropical forest zones as they do about savannas, such as referring to the existence of "localized diversity of micro-environments" (Bernstein and Woodhouse 2006, 152), they could have contributed to countering stereotypes about tropical soils and tropical ecosystems more broadly (cf. Brookfield 2001, 86–88;

Schaetzl and Anderson 2005, 388–392; Scoones 2001, 4; Stocking 2003; see also Kiage 2013).

Minqi Li (2006, 443) uses data presented and interpreted by Brown (2003) to argue that industrial expansion in the People's Republic of China (PRC) is causing widespread soil erosion and will probably raise strains on environments worldwide to overcome food production shortfalls. As pointed out earlier, soil erosion in the PRC has been overstated and is regionally specific, which means that vast areas may be little if at all affected by soil erosion to the extent often portrayed (e.g., Ho 2003; Schmidt et al. 2011). Moreover, relating food production to soil degradation is fraught with difficulties in controlling for the effects of political economic processes (e.g., input prices, government subsidy), interspecific relations (e.g., pathogenic outbreaks), and weather variability (e.g., short-term droughts) (see also Stocking 2003). Brown's interpretation of the evidence is to say the least debatable, making Li's argument rather weak about future crop productivity in the PRC. When more attention is paid to what soil scientists in the PRC are reporting, as Minqi Li does with Dale Wen (Wen and Li 2006, 138–140), it becomes obvious that the problems are multiple and much more insidious and long-term ones include crop heavy metal contamination from such sources as industrial processing plants, mines, and agrochemical applications (cf., Wong et al. 2002). This still does not support Li's earlier conclusions or it could modify the specificity of expected outcomes. In fact, if one were to assess the sort of impact soil degradation in the PRC might have on the rest of the world, one might also want to pay attention to widespread soil acidification from nitrogen fertilizer use (Guo et al. 2010), which could raise pressure on mining within the PRC, the world's largest lime production area.[10] If one is serious about organizing against capitalist encroachment with respect to environmental degradation, then one must have a fuller grasp of the environmental processes being considered. This can be helpful in devising pre-emptive strategies and actions.

The soil homogeneity assumption brings similar analytical flaws in the edited environmental history volume by Hornborg, McNeill, and Martinez-Alier (2007). Hughes' informative and insightful overview of environmental impacts associated with changing social relations in the Roman Empire departs from most such discussions by highlighting the diverse forms of impacts on soils, namely erosion, salinization, and heavy metal pollution. However, he does not provide any actual analysis of the evidence for soil degradation. Erosion is assumed to accompany the destruction of (or perhaps change in) vegetation cover, as if there were no erodibility differences. Sedimentation processes resulting from soil erosion are presumed to result in predictable locations of accumulation without any sedimentological research and without heeding the warnings of many soil scientists about erosion-sedimentation dynamics (see Chapter 4). Current landscape conditions in North Africa, for example, are mistaken for the results of past impacts (cf. Lowdermilk 1953) and salinization is traced to human impact without attending to climate change and its relationship to regional overall human impact. In fact, the timing of the crisis of the Roman Empire in the third century suggests that the cumulative environmental degradation was not decisive, given that the imperial system lasted hundreds more years. It would anyway be more of interest, from a leftist perspective, to learn about the relationship between social struggles and environmental change, rather than focusing on the relative stability of a rather horrific authoritarian system (see Chapter 4 on civilizationism). Widgren's discussion of landesque capital (investments in land improvement) and its effects on subsequent land use addresses soils only insofar as they enter economic valuation processes. The approach is unsurprisingly of soils as unchanging in themselves, as if only humans modified soils, and as uniformly changing according to human labor inputs. Soil dynamics are also regarded as though isolated phenomena. Soil erosion is taken up, for instance, but not analyzed relative to effects on other parts of the landscape, which could affect landesque capital elsewhere. In the rest of the works by Myrdal, Moore, McNeill, and Tainter, soils receive even less analytical attention in spite of the weight of the claims made regarding erosion and exhaustion. None of these studies account for soil dynamics as a result of failing to analyze soils and ignoring soil science research that would assist in such analysis.

The above-critiqued work by Moore, as a result of its laxity relative to biophysical data, also confuses similarity of human impact (which is often asserted, rather than shown) with similarity in ecosystem alteration, failing to account for ecosystem diversity and dynamics. In one instance, Moore (2012), in his zeal to show the interconnectedness of human impacts across the world resulting from capitalist expansion, pretends that soils in some northern temperate areas (parts of Poland) are indistinguishable from those in a few tropical zones (coastal Brazil). But soil diversity cannot be so easily papered over. They must be examined to detect the extent and form of impact deforestation and plantation systems had on soil conditions so as to gauge whether and how altered soil dynamics affected sugarcane and cereal crop production. The problem of assumed homogeneity is repeated in Moore's claims that the "capital-intensive family farm" in North America was involved in the "world-historical appropriation of soil and water, formed over millennia," creating "the conditions for cheap food" and major consequences in terms of reorganizing labor forces in different parts of the world (Moore 2011b, 130). This presumes soil diversity is irrelevant to food production at the continental scale and that sufficient information exists, at the same scale of analysis, about soil conditions and impacts on soils more than a century ago. But the same sort of impact, using the same technology, (e.g., a tractor), does not yield the same results relative to how soils change (e.g., clayey soils likely feature compaction effects under machinery, depending on technique, such as timing and frequency of tractor use). Regrettably, Moore has yet to demonstrate the world ecology side of the deal because he remains too focused on the social processes. At the same time, because of the fixation with capital, he largely misses social contradictions within capitalism and contemporaneous ecosystem changes brought about by other modes of production. If the aim is really to analyze the world, it is curious how most of it remains left out.

Being similarly remiss on the nonhuman side of the world, Williams (2010) treats soil dynamics ahistorically, as a matter of cropping suitability or nutrient balance sheets. With respect to the first, Williams identifies the responsibility of world financial institutions in dispossessing farmers of land, but then claims soil degradation ensued, without specifying where or what type, "because the crops now being grown were not suited to the soil, and farmers were pushed onto more marginal land, thereby accelerating soil erosion" (Williams 2010, 55). It is unclear whether he means growing crops in urban soils or new crops in the soils once cultivated by now displaced farmers. Either way, in places like Jamaica, to which Williams alludes, there are regions where many crops would be unsuitable anyway, as a result of low pH (Hennemann and Mantel 1995) and there is a sordid history of plantation agriculture that has not only been harmful socially, but has also contributed to changes in soil quality, sometimes for the long-term (depending, e.g., on pre-existing soil type). Plantations also do not necessarily bring negative impacts on soils. For instance, pine plantations have been found to reduce soil erosion more than the previous forest cover in Jamaica (Richardson 1982). Regardless, ignoring the hundreds of years of effects of slave plantations on soils is not flattering for an otherwise powerful, approachable leftist analysis of capitalism.

As for accelerating erosion on marginal land, one must always be mindful of local conditions of erodibility before making general pronouncements and the concept of "marginal land" should always be viewed with suspicion relative to what it actually means (is it marginal for maximizing cash-crop yield or for meeting local subsistence needs?). With respect to the second instance, Williams claims that in capitalism a problem like soil depletion is solved by creating another through the fertilizer industry (Williams 2010, 232). In fact, the application of industrial fertilizers has at times led not to depletion, but to the accumulation of nutrients like phosphorus. The overall pattern of capitalism is certainly one of degrading soils, but the link between capitalism and soil degradation should be shown, not assumed, because it also depends on the nonhuman factors involved. The lack of comprehension about soil degradation is also manifested in its entry on a list of "environmental threats" (p. 4). Once soil degradation occurs, it is no threat; it is an actually occurring process and sometimes a veritably irreversible disaster, in the case of activated acid-sulfate soils.

Finally, an entire thesis can fall when human impact is taken as the only changing variable and when there is no accounting made for changes in soils. For instance, Peet, Robbins, and Watts (2011, 25) posit that "Where markets are generous . . . capital is often available to reinvest in the environment, to rest the land, or to subsidize or maintain soil nutrients." Besides providing no support for such contention, it should be evident that impacts like sealing, compaction, or heavy metals and organochlorines contamination do not simply disappear by giving a soil some bed time. They can last for decades. Nutrients will not magically get replenished when soils are acidified or heavy metals contamination or excessive liming interferes with plant nutrient uptake. "Generous market" conditions do not necessarily yield soil nutrient recovery.

Exhausted Soils: Bedtime for a Tired Story

The above lack of appreciation for soil diversity enables the use of soil exhaustion[11] to explain past or current social change, especially in populationist rhetoric (see Chapter 5). According to this view of soils, different or similar human impacts result in soils depleted at virtually the same rates, irrespective of their wide-ranging diversity. It is surprising, especially in light of the above-described critical work on soil fertility and erosion discourse since the late 1970s, to find leftists referring to soil depletion as an explanatory factor without much qualification or supporting empirical investigation (e.g., Peet, Robbins, and Watts 2011, 24–25). Besides resting on little to no evidence, these kinds of arguments exemplify a lack of awareness of or concern for soils research and critical appraisals thereof. Relying on assumptions of soil depletion leads to tenuous arguments with sometimes unhappy theoretical (and political) consequences.

One could start by learning from the mainstream experts. Pedro Sánchez (2002, 2010), an authority in tropical soil fertility and head of Columbia University's Earth Institute, has used soil depletion (assumed to be linked to population growth) as an argument to explain malnutrition and/or famine in Africa. The insistent solution proffered has been simply to add mineral and organic fertilizer, surely a huge discovery for farmers. Yet, after decades of imputing food shortages to soil nutrient insufficiencies, the same Sánchez (2013) now describes a sudden change of fortunes (an "African Green Revolution"), promising an end to food underproduction and largely due to shifts in government interventions and policies that result in greater access and use of fertilizers, among other means of production.[12] Apparently, there is much more to soil depletion than adding fertilizer and stirring (cf. Pieri 1992; Scoones 2001). The uses of soil fertility to explain what is largely unrelated to soils (e.g., malnutrition in a context of agricultural exports and with food overproduction in many parts of the world) should serve as a lesson, but it appears some leftists have yet to heed it.

Merchant's ecosystem model of historical change rests on asserting a decline in soil fertility and accelerated erosion in the 1300s to explain the combined effects of population growth and landlord exactions in ushering "the breakdown of the medieval agrarian economy and ecosystem" (Merchant 1980, 47–48). However, if soil degradation does not coincide with the 1300s, mass famines necessitate other explanations. It is more likely that relations of domination would have created conditions for famine, rather than human-induced soil degradation, whose linkage to social change is very difficult to prove. In other words, it is entirely unnecessary to resort to soil exhaustion as part of explanations of past social change. Multiple environmental variables are typically involved in crop production and discerning soil fertility from other effects is already a formidable challenge in the present, let alone the past (see below).

On the other hand, Wallerstein (1974, 37), not as focused on ecosystem change, describes one theory explaining the crisis of feudalism as implying declining farming productivity due to soil exhaustion. He also repeats the notion that high nutrient demand from sugar cane plantation systems fuelled expansion into new lands (Wallerstein 1974, 44 and 89, 1980, 161–165). There are other examples of borrowed assertions about soil quality, none of which are supported by any evidence (Wallerstein 1980, 41, 132–133). Satisfied with magnified soil nutrient extraction being explained by economic cycles, Wallerstein misses the opportunity to question the validity of the assumption of soil exhaustion on its own terms. He also fails to account for soil and ecosystem diversity, which would enable him to appreciate the complexity involved in the relationship between soil type and sugar cane production. It is not a given, for instance, that nitrogen (a major nutrient) would impede the maintenance of sugar cane on the same land under labor-intensive technological complexes in the 1500s to 1700s. This is because many areas of Brazil feature abundant biological nitrogen fixation (Medeiros, Polidoro, and Reis 2006). Moreover, sugar cane tends to thrive in more clayey texture (nematodes can turn the crop more easily into their meal with sandier conditions) and tends to be tolerant of acidity and aluminum uptake (enhanced with low pH). These characterize some of the major soils in Brazil (Hetherington, Asher, and Blamey 1988), possibly contributing to the reasons for supply exceeding demand "more frequently in tobacco . . . than in sugar production" (Wallerstein 1980, 165; cf. Moore 2011b, 126).

Largely repeating Wallerstein's errors and omissions, Moore (2010b, 6–8) explains the crisis of feudalism in Europe by relying on assertions about occurrences of soil depletion, mere "irritations" under capitalist conditions, which, unlike feudalism, hinge on labor productivity. He thereby reinterprets the crisis of sugarcane plantations in Madeira in the 1500s as one of soil exhaustion relative to labor productivity. It is excellent on Moore's part to point out that soil fertility is contingent on social relations, but he seems to confuse actual soil conditions for estimations thereof, which are contingent on the politics of land use (see Chapter 3). A decline in soil fertility may be only relative to monocultural sugarcane plantations, but not to other cropping systems, and sometimes, depending on the diversity of soil conditions, it may not be a matter of soil exhaustion as much as prevailing techniques used and/or prolonged unfavorable weather conditions. By taking soil exhaustion and much else as given, he misses the opportunity to debunk a myth, which he reinforces, while he creates another by arguing for the inability of feudal systems to raise "land productivity" relative to "population growth" and ruling classes' resource demands, without any critical diachronic and spatial analysis of data on feudal population dynamics, its relationship to consumption patterns and thereby impacts on soils, or on actual soil and other environmental conditions during those centuries (Moore 2002).

Moore (2012, 83–84) similarly overstates his case by arguing for soil exhaustion in Brazil and Poland as propelling arable land expansion into forests, without considering the many factors involved and the bewildering soil variety that may point exactly to a lack of soil depletion and a rather different reason for deforestation. Likewise, presumed soil exhaustion in Poland, this time through both cultivation and erosion, is used to bolster an argument about a 50–75 year "socio-ecological" cycle of commodity frontier expansion and contraction. A historian's insistence on soil exhaustion in the 1660s is brought to bear to convince us of its link to massive downfall in farming production during the same period. The process was allegedly amplified by deforestation-induced erosion, leading to more nutrient losses. The fallacy of this argument regarding soil erosion has already been discussed in Chapter 4. To his credit, Moore consults pedologists (Klimowicz and Uziak 2001), something rarely done, but he misinterprets the findings. First, the study is limited to the Lublin Upland (SE Poland), where there is a predominance of erodible soils formed on loess or loess-like deposits. Second, the pedologists caution that "in the undulating terrain it was impossible to distinguish the extensive erosion resulting from the length of the cultivation period and the local erosion attributable to other causes" (p. 179). Farming, in other words, is one among other erosive factors to consider. Not too far away, Schmitt et al. (2006) report massive deforestation-induced gully erosion between the 1300s and 1500s in the Roztocze loess area, but as a result of iron and glass industry, not farming. What is more, the subsequent periods were one of managed reforestation until deforestation restarted in the 1800s. Even within a single area characterized by highly erodible soils, erosion sequences are highly variable both in terms of causes and chronology. Farming-related deforestation and soil erosion in the rest of Poland might be even more fanciful an assumption. Moore's commodity frontiers theory, resting as it does on presuming rather than proving "ecological exhaustion," is as tenuous as it is unnecessary to demonstrate the historically devastating impact of capitalist relations on people and the ecosystems of which they are part.

The much touted modification of "world ecology" prompted by the expansion of Eurocentered capitalism (Wallerstein 1974, 44) still must reckon with soil and ecosystem diversity before it can become a credible formula. In Wallerstein's later work, curiously, soils virtually disappear from any explanatory framework, as if to suggest their irrelevance to capitalism by the 1730s (Wallerstein 1989) or, more likely, the self-imposed irrelevance of such social theory to paleoecological investigation. This is not to discard the importance of looking into how places very far apart have come to be entangled under an overarching capitalist mode of production. Moore's undertaking is laudable, in this respect. However, this cannot be at the expense of finding out actual ecological change, which can also reveal the ways in which capital has been foiled by combinations of social struggles and ecosystem processes that are not socially determined.

Notably, it is not specialized scientists who, the Sánchez's of the world notwithstanding, resort to such exhaustion terminology or claims of plant nutrient declines in soils. And this is for good reason. Soil exhaustion is "system fatigue due to overuse," which is "a temporary change that can be remedied through change in land use" (Lal et al. 2004, 18–19). As Richter and Markewitz (2001, 4) underscore, soil "is rarely if ever completely exhausted, due to a continuity of inputs that include solar energy, OM, nutrients, water, and gases." Moreover, soil depletion implies crop productivity, which involves more than soils. This is one reason that soil nutrient status is not as easy to determine as implied by soil exhaustion proponents. There are actually many factors involved and analyses are further complicated when attempting to link soil nutrients to actual crop yield. For instance, there may be plenty of nitrogen in a soil, but it could be tied up temporarily on clay surfaces or in the bodies of micro-organisms, depending on what is influencing the biogeochemical cycling of nitrogen in a soil at a particular time. When it comes to crop yield, it is even more difficult to account for the contribution of soil nutrients because plant-growth factors like sunlight, seasonal rainfall patterns, temperatures, and the relationship of crops with other organisms can change from year to year. Soil nutrient status is only one among many variables to consider when attempting an explanation of crop yield patterns. Interpretations of past environmental practices get to be even more tenuous because the evidence order is reversed. Crop yield is often used to arrive at soil nutrient status, as if there were no other variables involved in plant growth. The least that needs to be done is to control for climate variables (e.g., seasonal temperature ranges, rainfall timing and amount), interspecific competition (e.g., weed infestations, pathogens), and below-ground community interactions (e.g., earthworm activity, fungal propagation) that affect the form and amount of nutrients available, to name only three salient factors. These are difficult enough to account for in the present, let alone the past. In fact, those that evoke soil exhaustion usually do not even bother to control for any variables, if they even comprehend that crops do not depend on soil nutrients alone.

Be that as it may, the notion of exhaustion begs the question of what is exhausted. There could be a depletion of OM, which not only affects the amount of nutrients, but water retention, soil temperature, long-term nutrient retention, among other properties. There could be a loss of acid-neutralizing (buffering) capacity, which not only affects the availability of nutrients, but can lead to heavy metal toxicity problems in plants. There could be a decline in nutrient availability as a result of the accumulation of salts in a soil. Stating that soil depletion is happening therefore does not say much about why nutrients are unavailable to crops and it does not distinguish between nutrient unavailability and actual nutrient decline in a soil (e.g., by way of leaching, harvest export). There can be, in other words, bad harvests with little to no nutrient decline as a result of other changes in soil properties. This alone should make one wary of soil exhaustion arguments, but it requires a study of soils to arrive at such precaution.

Even if one does not care about making such distinctions and one is just interested in whether nutrients are available to crops or exist in sufficient quantities in a soil, it makes a rather substantial difference which nutrients and whether they are macro- or micronutrients. This might appear pedantic until one understands that what can lead to reduced or stunted crop growth (and thereby yield) can be due to insufficient amounts of a single nutrient, not of nutrients per se. This would mean, in the case of nitrogen (a macronutrient), that replenishing nitrogen levels would reverse the problem relatively readily by, for example, growing leguminous cover crops and/or spreading manure. But if the difficulty is with having enough phosphate (as in much of Australia) or some micronutrient, such as boron, then it will take much greater effort to raise the levels of those nutrients (e.g., mining to produce phosphate fertilizer or select phosphate-rich manure) or crops will likely have been selected that do well under such conditions. What is imputed as a generic problem of soil nutrient depletion may pertain to one or several nutrients and the question could be about fertilizer inputs and crop selection, rather than about soil degradation.

This is an especially important aspect to consider when explaining people–environment relations in the past. Soil exhaustion is often used to explain social problems, such as increased economic pressures on peasants or peasant unrest, or environmental impact, such as farmland abandonment or increasing deforestation. In light of the above, this would be to commit at least two major errors of interpretation. One is misconstruing the problem. There may actually not have been much soil exhaustion at all and instead a temporary reduction in one or more nutrient, which can be remedied, depending on soil type. The focus then needs to be redirected towards the ecosystem and social processes that prevent nutrient replenishment. There may also instead be other environmental factors that have little to do with soil nutrients, such as greater pathogen activity. Another error is founding entire interpretations of the past on mere assertion. Exhaustion is simply assumed to have occurred and, adding assertion upon assertion, to be directly tied to the amount harvested.

Soil exhaustion arguments rest on unsupportable assumptions that, when used to explain social upheaval, become a veritable house of cards. It is therefore unsurprising that interpretations of history founded on a soil exhaustion thesis can be so easily disproven as soon as one includes evidence of other influencing variables, like politically driven constructs (e.g., Earl 1988), changes in agricultural techniques (Benjaminsen, Aune, and Sidibé 2010), or past regional climates (e.g., Simms 1982). Claims of soil exhaustion as a socially disruptive factor, rather than reveal any social effect of environmental change, usually betray a lack of knowledge of soil processes that can lead to misinterpreting environmental change and misrepresenting causation. Rather than simple robbery (i.e., depletion of nutrients by grain harvest and export), as some describe the process, uncritically borrowing from Marx (uncritically borrowing from Liebig), soil nutrient decline implies a matrix of multiple sources and exchanges, of harvest extractions relative to nutrient-holding capacity (involving also intrinsic soil properties) and additions from people and many other sources.

Actant Soils: Death by Actor-Networks

Actor-network approaches, alternatively, could enable the supersession of such blatant failures to attend to actually existing ecological relations. Yet for all the promise of overcoming dichotomies and including nonhuman agency, actor-network theorists seem to be baffled by soils. Latour (1999) hops to the Amazon to follow soil scientists at work and uses soils research to prove his notion of circulating reference. In this manner, he completely misunderstands the scientists' grassland-forest study by paying attention more to the differing terminologies of the scientists (a botanist, a pedologist, and a geographer) than the substance of the research. Failing to educate himself about soils, Latour becomes a ventriloquist making the pedologist claim such absurdities as "savanna . . . degrading the clay soil necessary for healthy trees into a sandy soil in which only grass and small shrubs can survive" (Latour 1999, 27).[13] Losing himself in a circular reference of his own making, Latour scuppers the chance to persuade scientists of the merits of his approach.

In contrast, Robbins' excellent study of lawns, where Althusser's ideological state apparatuses meet Latour's networked actants, curiously leaves out much of the turf from the elaborate lawn people networks so eloquently unfurled to explain persistent biocide use (Robbins 2007). The diverse and numerous soil-dwelling organisms and the mining concerns behind the mineral components of turf are systematically excluded (see Chapter 3). Yet such manufactured soil would reveal a much greater and denser network that would explain the fate of biocides and the full workings of lawns, as part of urban soils rather than residential units. And with that soil go all the organisms that also enable the grass to grow by affecting nutrient availability, aeration, water flow, and many other processes crucial to plant life.

Duvall (2011), on the other hand, discusses the plausibility of treating soils as actants in "scientific actor networks" that (amazing discovery) are only inert relative to human life spans and that may diverge from the roles assigned by scientists. As if taking readers for a ride, he examines not soils, but the divergence, since the 1950s, of settler colonial scientific theory about ferricrete (an indurated iron-rich soil layer) in Africa.

Although authors cannot be expected to cover all the possible areas revolving about a theme, the oversights in these works are no accident. They are products of actor-network approaches themselves. In their hasty dismissal of positivist science, they take for granted or downplay (if not ignore) the scientific knowledge that is actually central to explaining the networks and even the emergence of the actants. Ironically, actor-network approaches become more effective at annihilating nonhuman agency than conventional scientists studying biophysical processes.

In the case of Robbins, urban soils findings that pertain directly to lawns are summarily eliminated through actant selection. Duvall, in contrast, conflates a duricrust type of soil layer (ferricrete) with the entire soil and seems uninformed about the wide-ranging rates of change of soil processes (from split seconds to thousands of years) or the sheer bustle of life forms and physico-chemical reactions that typify soils. By treating soils as actants operating over a single time scale, the analyst erases the agency of all the organisms, as well as the water, the air, and the mineral and organic materials that compose a soil.

Secondly, analytical categories seem often confused for existing subjects. This process of reification comes into full bloom when actor-network theorists attempt to capture soils with their flattening nets, downsizing soils to actants, as Duvall and Latour do. The notion of soils as single, internally coordinated units thus returns us to nineteenth-century agricultural chemistry and evinces the great strides made in social theory by ignoring the biophysical sciences.

Reification is connected to a third problem, the limit imposed on the scale of analysis and of the actants selected. It is an arbitrary limit that exposes the disingenuousness of claiming to examine phenomena without preconceived notions of hierarchy, power, and other such purported research crimes (for an overview, see Castree 2002).[14] It may be unclear whether clay minerals or entire soils should be regarded as actants, but it does seem clear enough who decides on defining the actants. The plug for the happy "parliament of things" carousel is controlled by the person carrying out the research and the social power relations in which the researcher is enmeshed. Nonhuman subjects are not in some queue waiting to be selected by humans for enrolment in the carousel. The joke is on the actor-network analyst who, by not actually studying or interacting with nonhuman processes or beings, confuses social interactions with relations among people and nonhuman subjects. Happily, there are scholars like Robbins who avoid such confusion by closely attending to research on biophysical processes (save, as yet, for soils and the much larger actor-network they would force upon the analysis).

Finally, there is a tendency for people–environment interactions to rely on nonhuman agency, implying a prerequisite for actants to be capable of actively shaping their world. This transfers with great difficulty to phenomena like, say, sand particles. This problem could be circumvented if the presumption of methodological equality among actants is relinquished so as to allow differential world-shaping capability. In the case of soils, due attention to their composite status, rather than treatment as homogeneous masses, would markedly improve analysis. Unfortunately, in current actor-network approaches to soils, agency is entirely effaced, as soils, when they are not disappeared, become inert substrate. Duvall's intervention only deepens the argumentative hole by pointing out, incorrectly, that such passivity is relative to a rate of change beyond human life spans (temporal scale), thereby throttling all the actual liveliness in soils while trying to rescue them from their assigned passivity. It is certainly useful to pay "close attention to the details of scientific practice" (Latour 1999, 24), but not when one disregards the subject towards which scientific practice is directed.

CHAPTER 7

TOWARD AN ECO-SOCIAL APPROACH TO ENVIRONMENTAL DEGRADATION

While some critical works offer alternatives on ways to analyze and interpret biophysical processes like soil degradation, they are often short on social critique, stopping precisely where leftists usually begin, such as in arguing explicitly against capitalist social relations and, rarely, developing ideas about egalitarian anti-capitalist alternatives. Comparatively, the left has been long on critique but short on developing alternative ways of understanding and explaining biophysical processes, especially soils. One way that such problems emerge is by failing to incorporate into the analysis what is known about the biophysical processes related to the type of environmental degradation investigated. This volume is an attempt to addresses this missing aspect of most leftist scholarship. It draws from what others have already developed theoretically regarding environmental degradation, but underlines the relative independence of the "natural bases,"[1] which form the analytical starting point of research on people–environment relations; hence the preference for the term "eco-social." That is, the ecological or biophysical being a much larger multifarious set of processes, ecosystem precedes the social, even if it is we that sense, know, interpret, analyze, in other words, determine its meaning. To state the obvious, this is evident in our very bodies, an ecosystem in itself. The heart beats regardless of our awareness of it and yet that beating plays a fundamental role in enabling us to be aware. Soils degrade regardless of our awareness of that process and even without human intervention, and yet they, as ecosystems, enable us to have consciousness through food production, water storage and flow, and much else.

This way of approaching people–environment relations resembles Élisée Reclus's implied understanding, where first the globally more encompassing nonhuman dynamics are discussed, such as oceans and climates, with social processes squarely within a host of natural ones, such as life forms generally (Reclus 1869). Methodologically, however, this eco-social approach draws from Marx, who proceeded from a common, unremarkable social product (e.g., the commodity) to unveil the workings of an entire mode of production (e.g., the capitalist one). In the case of people–environment relations, I suggest starting from a biophysical process (e.g., soils) to expose the workings of specific eco-social relations (e.g., soil degradation in capitalist contexts). This was how this volume to a large extent proceeds, starting from soil and its dynamics. Along the way, I discuss soils' relative independence from and inherent ties to social processes (e.g., soil knowledge, classification, evaluation) and hence soil degradation as a set of soil dynamics specific but not reducible to ways of impacting and understanding soils in predominantly capitalist contexts (one could do the same for dynamics involving soil development in connection with another mode of production).

Soil, as one way to discuss the biophysical, what cannot have agency in the organismal sense, is also what has been missing by and large in leftist worldviews. This is so even when one offers an alternative dialectical evolutionary approach, as David Harvey has (1996, 190). That is a much more profound and fecund perspective than the one developed here, but environmental forces remain passive, inert, subject to transformation. Compared to the herein advocated eco-social path, a largely opposite route and objective are taken, along the way losing the environmental subjects. The departure is from a social or socially induced environmental outcome (e.g., crisis narratives about the environment, global warming) and, with biophysical processes sometimes almost a mere pretext, the destination is an essentially social outcome (e.g., reinterpretation of environment, capitalist relations). But sidelining the biophysical subject does not make it disappear. And, as shown in the preceding chapter, once we return to the biophysical, it can wreak havoc on inattentive leftist theories and politics.

An Eco-Social Framework

Despite persisting uneven geographical spread and quality of soils information, numerous case studies from many parts of the world (beyond faulty national inventories, unrepresentative field experiments, and crapshoot simulation models) support the contention that soil degradation is occurring and is worldwide. However, the scientific knowledge produced about soil degradation has to be critically appraised. Briefly, the very notions of soil and soil quality have to be clarified and related or compared to the actually lived experiences and knowledge of those using soils. Whether a soil is degraded or not will depend not just on qualities observed in the soils themselves but also on the uses and conceptualizations people have about soils. This entails comparisons among points of view and data-gathering methods before any conclusions can be reached. Ascribing value to changes in soil properties (positive or negative, for example) has to relate to social context.

Once it is determined that a soil is degraded according to soils experts involved (not just outsider scientists), then the process can move to explaining soil degradation. The issue is not only what people are doing and in what way (by whom?), but also whose perspective or benefit is represented and/or reinforced (for whom?). In other words, not everyone is directly contributing to degrading soils or to defining what soil degradation means. In many societies, some people are more socially empowered than others to exert an influence over how soils are used and to what purpose (power relations), what even constitutes soil degradation (authoritative knowledge), and what is to be done about it (legal frameworks, policy, enforcement strategy, etc.). One should further consider that the type of impact depends on the outcomes of place-specific and mutually influencing people–environment relations. Human impact on soils involves multiple meeting points in a complex of nonhuman and human processes. So the modification of soils, whether positive or negative, should be studied as the result of both wider environmental dynamics and processes specific to a given social system, along with their connections to processes elsewhere and to planetary effect.

Here is one idea of how to proceed analytically to make sense of soil degradation. After careful scrutiny of scientific knowledge (data-gathering methods, soils data and their interpretation, etc.), several processes could then be considered in the analysis and explanation. This was in essence the example discussed in Chapter 1. The approach can be schematized as a quadripartite framework whereby four processes must be considered all at once (to the extent possible):

(1) soil and associated ecosystem dynamics;
(2) social and ecological/soil interactions and histories;
(3) interconnections with social contexts elsewhere (the larger scale of social processes); and

(4) interconnections with larger-scale ecological processes (which include human impacts).

Much like non-equilibrium ecology, these processes have to be understood according to their multiple aspects of time (duration, rates, and range of change) and space (extent, degree and type of interconnectivity, and heterogeneity). In short, the manner in which social and soil processes are connected and the manner in which the connection is understood depends on how long (or for how many generations) people have lived off specific soils, how and to what extent people deal with soils as part of everyday experience, and what kind of changes have happened or are happening in a society and in an ecosystem. All these processes contribute and are related to what happens and/or has happened in other places.

These four general processes should be considered always present and interacting. As they interact, they generate diverse permutations of soil degradation or human-abetted soil stability or, in terms of wider applicability, of people–environment relations. The processes are necessarily social and nonhuman at the same time and together create multiple scales for different phenomena, as others have also underlined. Borrowing from Levins and Lewontin (1985) and Harvey (1996), the interactions among the four processes are mutually constitutive (dialectically related). The emphasis here is also on the interactions between the biophysical and the social (e.g., social relations and biogeochemical cycling of nitrogen and phosphorus), not only those within one or the other, and this means prioritizing different sets of questions and research objectives that necessarily leave both social and biophysical scientists dissatisfied.

A brief example of focusing on interactions is via human impacts leading to accelerated soil acidification in a humid temperate zone floodplain. This can necessitate the use of lime (leading to greater pressures on communities near large mining operations), if such lime can be had, or the abandonment of food production in affected areas, or other such social changes that, in turn, bring about different land uses affecting soil quality. This could be in the recovery of soil acid-neutralizing capacity sufficient to reintroduce food production or this could be in the permanent alteration of soils leading to other uses, such as a coniferous plantation or a parking lot, depending on political dynamics and outcomes, which largely determine land use decisions (with the understanding that environmental practices and their outcomes depend also on nonhuman processes). A coniferous plantation would likely result in further acidification, and a parking lot would be tantamount to soil sealing and raising water runoff velocity. Social relations behind human impact (e.g., pressures on farmers to maximize cereal crop yields by using urea-rich fertilizer, leading to accelerated acidification) constitute and are constituted by nonhuman processes (relatively high rainfall providing a tendency for soil acidification in the first place). As we impact and modify environments, we are changed in the process.

Underpinnings of an Eco-Social Perspective

Much of this endeavor has in common with what has been called political ecology, but mostly the variant that has involved actual research on social and biophysical dynamics, rather than just focusing on the human part of nature. The latter focus continues to overwhelm leftist approaches on environmental degradation (e.g., socionature, produced nature, cyborgs, hybrids, world/Earth systems). Doing so affects research priorities and the form of political struggle, among other consequences never quite openly discussed. At the same time, those perspectives usefully overlap (or may be redundant) with what Marx had already identified, which is that people are part of nature and dialectically related to it in a differentiated unity (Harvey 1996; Loftus 2012, 32–35; Marx 1867, 173). These days the overlap may come a bit short in some approaches on the dialectical part (at times regarded as just another dichotomy), as Castree (2002) sharply notes. Yet the social continues to be so pronounced, if not overstated, as to diminish an already exiguous understanding of the nonhuman in social theory.

Dissatisfaction with these approaches stems from my unease with an ontology that, in a justifiable allergy to society–nature dichotomies and dualisms,[2] treats other organisms and physical forces as inseparable from society and centered about social relations. The problem, however, is not about whether they are separable. If the privileging of the social is an outcome of fretting over environmental determinism or essentialism, the solution would be much easier than the convoluted expressions and theoretical contortions on offer. It should be enough to call obdurate dichotomists or dualists out for the ontological farce of pretending that we are outsiders to life or physical forces. For if we are, we might as well call ourselves supernatural or dead and do some impressive intellectual gymnastics to explain why we are made of elements also found in things and other beings, to explain what enables us to live, like the microflora and other organisms dwelling in our bodies, to explain the constant cycling of water and minerals between us, other organisms, and the physical environment, or to explain how we come into being in the first place. What is brought about by human beings' actions or consciousness and even consciousness itself is impossible without things and other beings that compose our very bodies.

There can instead be a qualified, non-hierarchical differentiation between us and the rest of nature (or artificial and natural), which seems the usual alternative, but this makes for an impossible equivalence or for a reduction of nature to what is or can be differentially sensed or experienced by people (see also Harvey 1996, 194). Contrary to an appeal to some inherent mixed bags that pretend not to rely on separation to arrive at mixtures or networks (hybrids, socionatures, etc.), the rebuttal to the usual dichotomy could then be stated thus: humanity (or society) is incommensurable to what encompasses countless things and beings. In other words, juxtaposing society and nature is ludicrously vague and obscenely inaccurate. It is vague in that the actual relations that we confront and that markedly differ from each other are collapsed together, whether viruses or plants or buildings or solar radiation. It is inaccurate because people never confront the totality of the rest of nature (and in any case confront parts of it differentially). The universe is much too large for that. In fact, so are soils, and people rarely interact with entire soils, but usually with bundles of processes manifested within the topmost horizon.

None of this argumentation is really new, and it adds mainly a difference in expression and emphasis. Yet many professing to overcome what are patently false dichotomies or dualisms either pretend a flat world of ready-made agents or tend to fixate so much on the social (or on making the biophysical intelligible to social science) as to impede discernment and analysis of nonhuman processes. The former set of views paper over enormous differences in capacities (power) and frequently stop short of asking who determines the scale of analysis, what/who counts as nonhuman, and the conditions under which the nonhuman features as part of a story, thereby evading issues of power relations (cf. Castree 2002; Kirsch and Mitchell 2004; Latour 1991; Robbins 2007). For the latter set of views (cf. Haraway 1991; Harvey 1996; Moore 2011a; Salleh 1997; Smith, 2006; Swyngedouw 1996), the processes in our bodies that happen beyond our consciousness of them or the discovery of anything new outside the social become unnecessarily difficult to explain or even to research, since one is to be interested only in what is socially produced or co-produced with society.

Because for me studying soils, not only society, is fundamental to explaining soil degradation, my propensity is for a process ontology that insists on not two or several (e.g., networked actants), but countless inter- or unrelated forces (processes) with highly differing powers (in both positive and negative senses), within and beyond our awareness (Gare 1993, 145–148). Viewed this way, the unexpected, the contingent, or the unintended of many scholars' people–environment narratives is an impoverished way to describe the outcome of often analytically unwieldy interactions among many disparate and (semi)autonomous beings and forces (Robbins 2007, 137). This kind of ontology enables research informed by social theory to tear away from the asphyxiating society–nature compartmentalization in the sciences and venture into such areas as paleopedology, without which it would not be possible to explain soil formation processes. To comprehend and explain people–environment relations, the study of processes happening without direct or even indirect human intervention is as important as the study of social relations. Such a multi-process ontology is thus not an alternative, but a complement to the above-cited perspectives, which are not obsessed as I am with biophysical processes. Studying nonhuman processes compels me to recognize an enormous qualitative and quantitative asymmetry between the biophysical and the social that is within it. This says nothing regarding the nature of (semi)autonomy. Some presume that positing such relative independence leads to essentialism or even depoliticizing environmental degradation (White 2006), but such concerns are misplaced. To paraphrase and add to Lenin (1908, 102–104), our identifying or knowing a process does not determine that process' existence, but this does not mean that such a process has the same capacities or status as people or other processes.

Lest one get all worked up about implications of environmental determinism in this argument, let me emphasize that to recognize society (humans) as one (actually tiny) part of nature is not to subordinate the social to the ecological, nor is it to minimize the influence of human impact on possibly the vast majority of ecosystems the world over. On the latter aspect, there is much evidence in support of there being a disproportionate influence by a single species (or, more precisely, sub-populations of a single species), but it does not mean having overall a greater influence than all other natural forces combined. For instance, with respect to climate change, we are living in an interglacial period, peppered by stadials (cooling) and interstadials (warming). It is a global warming trend that spans millennia. Human impact is accentuating an already occurring phenomenon and, conceivably, the same phenomenon could be mitigated by combinations of nonhuman forces. In future, any simultaneous large volcanic eruptions, for instance, could reverse the process and lead to a global cooling trend, depending on other nonhuman factors, only some of which can be affected by human impact (e.g., ocean currents, the distribution and behavior of photosynthetic organisms). There is much at stake here that is also political. Pinning the course of planetary environmental change on the overcoming of a set of relations within sub-populations of a single species will constitute yet another loss of credibility for the left if nonhuman forces combine to reshape global atmospheric dynamics toward less drastic outcomes than anticipated. The notion that one species can change everything simply by reducing its own impacts should be considered absurd and politically short-sighted.

Similarly faulty is any melting of the social into a generic ecological. Our understanding of nature is, in part, a social endeavor, as is our existence in general. In this, I am repeating what many already have stated in different ways, including Marx (1844). We are a distinct species, but are part of nature. The matter can be summarized quite simply. When studying a soil or a population of ants, it is we that do the interpretation of what we observe, not the soil or ants. A soil is not going to educate us about how to observe it, define it, delineate it, sample it, or anything else related to their study. Ants, similarly, do not tell us how to identify them, systematize their behavioral characteristics, sequence their genes, and anything else myrmecological. It is people that teach or otherwise show other people what to observe, how to observe, how to interpret results, and all the other processes involved in studying physical environments or nonhuman organisms.

At the same time, it is not our socialization into specific observation and understandings of environments or nonhuman organisms that determines their existence or our observation of them. There is constant interaction between the observer and the observed (and who is doing the observing could also be questioned, at least relative to other organisms; the observer–observed distinction is not so clear-cut) and the interaction is not reducible to observer–observed relations, so what we observe is also shaped by physical processes and/or other organisms. To give some mundane examples, the very act of digging to expose a soil profile alters the soil itself and severe weather can disrupt and modify the investigation of a set of soils and even alter their characteristics (e.g., a large sudden influx of salts on coastal soils or a sudden high erosion episode due to a hurricane or a tsunami). Similarly, knowledge about ants is not just the result of our observation and study of ants. Some researchers, for example, have described fire ant queens (*Solenopsis invicta*) flying, after mating, at low altitudes in large numbers, periodically landing in different places, and with almost no accompanying males. This was something previously unknown to ant specialists. It has led to new understandings in that such swarms seem directed at finding multiple-queen nests where they can be accepted as new reproducers (Goodisman, De Heer, and Ross 2000). Irrespective of some scientists' recourse to genetic determinism to try to explain ant behavior, a determinism regrettably shared by most entomologists (and too many others), it is clear that it is the ants themselves that, through their activity, showed the observing scientists something that forced a rethinking of this particular type of ant behavior.

Scientists studying soils or ants have been motivated socially and have been taught their respective fields of study; they are in conversation with other scientists and people at funding institutions about the subjects they study, responding to, refining, or applying other scientists' theories and dealing with what institutions like universities and/or funding agencies deem important or legitimate. Scientists sometimes consciously or unconsciously reproduce current bourgeois ideologies about nature (which are really about society). However, these social processes form but one of many other factors that, in the study of nature, are not human in origin. This interaction between nonhuman worlds and the social aspects of scientific practice has been pointed out by many others, especially in the critical study of conventional science. Our understanding of environments or ecosystems is therefore much more than social. It is an eco-social process, involving interactions between people, other organisms, and physical processes. But this understanding is always partial not only because of the impossible omniscience implied in scientific objectivity ideology (Haraway 1991), but also because it is impossible to study all of nature (and often even just one ecosystem) at once, in its totality. There are always many other organisms, many physical forces that are involved and make a mockery of any scientific certitudes about nature (including our own). Knowledge of nature is necessarily provisional because it is predicated on the shifting outcomes of the interactions of multiple natural processes, including social ones. In a way, for a leftist take on ecology, one could start by amending Marx's insights on history (Marx 1852) so as to forge out of it an eco-social grasp of history. People make their environments (and bodies) only in part and under pre-existing conditions resulting from past environmental change and people–environment interactions.

Epistemologically and methodologically, this eco-social approach implies that one should not privilege any one of the above-described process or use any one of them as a primary starting point. The analytical starting point is all four processes at once. Otherwise, if one begins with or emphasizes one of the processes, overriding or potentially key aspects of a socio–environmental problem can be missed entirely (for some examples, see Engel-Di Mauro 2009). The feasibility of analyzing all four processes depends on available data and on what is considered legitimate or relevant knowledge. Hence there has to be cognizance and investigation of the politics of (or struggles over) resource allocation for different types of research and of knowledge production and diffusion (this is something that continues to be understated if not elided in, for example, actor-network theory; the "enrolment" of the nonhuman is also a political process).

Political ecologists that actually study biophysical processes or other organisms seem closer to this kind of eco-social view. Where I might part ways with likely many such political ecologists is in their zeal to demonstrate the contingency and complexity of people–environment relations (the highly differentiated nature of environmental degradation) at the expense of formulating a perspective mindful of overarching systematic tendencies. Recognizing overall unity or sensing a common set of relations operating through disparate processes does not necessarily lead to being remiss of differentiation or to privileging unity or globality over difference or specificity. More importantly, the issue is one of political strategy. In a context of immense chasms in power and material well-being and of widespread oppression and destruction, separating unity from difference is a more pernicious dichotomy. This is what animates my search for a general theory of soil degradation related to capitalist social relations.

TOWARD A GENERAL ECO-SOCIAL THEORY OF SOIL DEGRADATION AND CAPITALIST SOCIAL RELATIONS

There are actually enough data, insights, and analyses so far on soil degradation that any timidity toward a general theory is as unwarranted as leftist theorization devoid of biophysical approaches. It is not enough to critique predominant views on soil degradation with contravening evidence or analyses. Even if it could use refinement and more data, a theory can and should be developed to counter explanations of soil degradation as caused by population density, poverty, mismanagement, and any other such superficial understandings of social causes. Very briefly, and something to be taken up more thoroughly in a later volume, there is, in spite of chronic underproduction of soils information, a highly destructive tendency inherent to the capitalist mode of production, for reasons already well explored by many. However, to return to the insights of Piers Blaikie (1985), this is not necessarily resulting in any fatal contradiction, underproduction crisis, peak soil, or any catastrophe.

Soil or environmental degradation should be rethought as two interrelated eco-social fields. One is the set of biophysical processes involved and that includes society. That is, one field is the socially caused actual modification or destruction of soils such that human life cannot be supported or is debilitated. The degree to which such is the case depends on variable physiological needs among affected people. The level of threat soil degradation poses is difficult to determine without detailed contextualized data gathering and analysis and without studying biophysical processes. Another eco-social field is the set of social relations of domination. These include the capitalist mystification processes of raising alarm where there instead needs to be more research and of developing (poorly supported) arguments targeting anything but the powers that be. Stated differently, depending on the historically variable and mutually influencing relationship between people and soil (or other ecological) dynamics, capitalist destructive tendencies (1) have resulted and are resulting in actual devastation for many (but not all) of the least empowered communities and (2) are creating problems where they arguably do not exist (e.g., soil exhaustion) so as to facilitate the intensification of capitalist control over the means to life, as many have pointed out (e.g., Mies and Shiva 1993; Swyngedouw 2007).

The secret to sustained soil degradation under capitalism in areas of the world where this can be confirmed, especially industrialized settings, lies in the interrelated occurrence of more soil resilience and regenerative capacity than appreciated, the existence of soil that remains exploitable for capitalist ends, the emergence and spread of often gendered sustainable practices by way of widely different communities resisting within capitalist systems (e.g., anti-colonial movements, organic farming associations), colonial parasitism on contemporary sustainable practices in non-capitalist societies, and the often forgotten benefits inherited from millennia of past non-capitalist uses of soils (e.g., terra preta, plaggen soils, soil enrichment through past sedimentation). This is but a preliminary reading and much more information and analysis are necessary to support, modify, or reject this explanation. Eventually, it would be even more useful to carry out a project focused on the mutually constitutive connections between multiple modes of production, differential impacts on soils, and soil processes.

Discerning the wider biophysical from the social relations that affect its understanding requires attention to another set of interrelated processes. One is the scientific or analytical (claims relative to evidence) and the other is the interpretive or perceptual (interpretations and approaches to soils, within and beyond science). The heterogeneity of experiences and understandings of the environment is forced into a sieve of scientific evaluation, buttressed and legitimated by state authority, and funneled into a relatively homogenized notion of the world, one that better reflects the prevailing current ideology while not steering too far from nonhuman worlds, the backbone of our collective existence. The relative elasticity in the range of possible physical practices and plausible interpretations (ideologies) lies in the outcomes of the interplay between people–environment relations and relations of domination. This thesis and research agenda might find much disagreement among the disparate critical and leftist approaches to soil degradation. However, perhaps this manner of summarizing the problem of soil degradation could be useful at least in countering the recurring facile blame on people with the least power or diversionary forays into insufficient market access, private property security, and other explanations that take capitalist social relations as universal or desirable.

Ecology as if the Nonhuman Existed

Leftist objectives must expand beyond the critique or uncritical (if not poorly informed) use of knowledge about biophysical processes. Generally, a tendency for an equipollence of society and nature and disproportionate attention to social relations has resulted in tenuous or overly abstract theorization about environmental degradation and this can undermine both theorization and political strategy. To concur with Ariel Salleh, there needs to be "a materialist analysis of social relations, as well as a materialism that engages with ecological processes" (Salleh 2010, 205). However, the latter simply cannot develop by continuing to concentrate overwhelmingly on social relations and to narrate a story of society on one side and generic nature on the other. There is no interaction between society and nature, if one really takes seriously the perspective that society is part of nature. Likewise, there is no interaction between society and the rest of nature, only aspects of it and in specific contexts or configurations, and so they must be studied accordingly. Abstractions like ecology, environment, and nature are impediments to both theory and practice when devoid of concreteness and specificity and especially when divorced from the practice of producing knowledge about the rest of nature. Studying soils by treating differentiated human action as one among other factors[3] is one way to overcome these recurring weaknesses on the left. Studying soils is an enormity in itself, yet much more feasible a project than pretending to cover the entirety of some abstract nature. It is more appropriate to speak of some people in particular contexts interacting with some nonhuman processes (soils, but never really in their entirety), leading to mutually changing effects.

This need not lead to losing oneself in a morass of details. As Joel Kovel (2003b, 134) has succinctly put it:

> Any given ecosystemic problem requires close attention, often along scientific lines, to the peculiar pathways according to which it unfolds and can be resolved. But the ecological crisis is a function of the whole: of the entire set of such crises, of why they are growing explosively under present circumstances, of what drives them forward, and of what can be done to overcome the pressure causing disintegration of our natural foundation. "Science" cannot answer any of these questions, and when it pretends to do so becomes part of the problem.

And science, imbued with capitalist ideological constructs, becomes part of the problem not only in pretending to answer questions of, say, soil degradation, but also in generating decoys or false problems (such as population pressure or maximizing average crop yield). Still, identifying and countering such ideology is insufficient. Leftists themselves must carefully study ecological change according to its peculiarities and without losing track of the overall outcomes (the configuration and interlinking of what are too often regarded as unrelated processes, such as gender relations and soil dynamics). This implies symmetrical significance to both in explaining and acting upon the sort of ecological change by now likely if not already disastrous to many people. This view ought to include an understanding of the ecological as being far greater and more diverse than the social so that the social causes (and understandings) of soil or environmental degradation can be discerned to avoid conflating social and environmental changes. Put another way, a change within a society (i.e., within a single species) cannot result in predictable or overall change in the rest of an ecosystem or the planet (much less the rest of the universe). Capitalist impacts on soils, such as heavy metal contamination, will likely endure beyond a capitalist mode of production, much like past human impacts leading to soil enrichment with OM have outlasted the modes of production that resulted in such impacts. But the future effects of contamination will also be contingent on myriad processes involving microbes, vegetation, microclimates, and mineral weathering, among other nonhuman processes. The degree of organic enrichment from past human impacts differs according to combined nonhuman organismal, climatological, and topographical influences. That is to say, the processes of soil formation, development, and demise are not reducible to human intervention and neither is the rest of nature. This should be reason enough to struggle against both the capitalist mode of production (with its widespread destructive eco-social effects) and politically self-destructive, undialectical notions of future harmony with the rest of nature (cf. Kovel 2003a, 78). The irreducibility of the nonhuman also makes it imperative for leftists to immerse themselves in the study of biophysical processes and in the production of knowledge that contributes to identifying and addressing the concrete, everyday environmental challenges that do not simply wither away with the development of an egalitarian society.

NOTES

SERIES EDITOR'S FOREWORD

1. Just to give a brief indication of the complexity of soil properties and Engel-Di Mauro's discussion of them, consider some of the components of the chemical properties of soil: organic material, pH, buffering capacity, salinity, carbonate content, amount and kinds of ions, to name just a few, or the complex living organisms under the biological properties of soil that leads the author to say, "soils teem with life": bacteria, fungi, protozoa, slime molds, algae, roundworms, mites, earthworms, etc. (see Chapter 3 for full discussion).
2. Christopher Uhl. *Developing Ecological Consciousness: The End of Separation*. Lanham, MD: Rowman and Littlefield Publishers, 2013, p. 206.
3. *Ibid*. p. 239.

CHAPTER 1

1. Leftist herein refers to anyone openly naming and critiquing capitalist social relations and seeking to contribute to building an egalitarian society. In this sense, those high on critique but not expressly anti-capitalist and anti-authoritarian are not leftists, but they certainly are critical, so that is what they will be called here. Admittedly, this view might irritate some for being narrow or exclusionary and others for being vague or simplistic. Greater precision would, however, require too lengthy a diversion and too cumbersome a suite of terms to be useful for discussing the kind of subjects broached here. The reason for not using radical rather than leftist is because radicalism does not reside within leftist movements alone.
2. A salient example is the isolation of the antibiotic streptomycin from the soil bacterium *Streptomyces griseus*. A recent study indicates that antibiotic resistance in soil bacteria could even lead to improving the effectiveness of pharmaceuticals (Tomasz 2006), which under capitalist control, is another way of disconnecting people from soils (and one's body) by turning soils into separable compartments and into commodities to be mined to extract new sources of profit.
3. By these terms I mean soil scientists and specialized physical geographers, agronomists, geologists, environmental scientists, and the like.

CHAPTER 2

1. Ethnopedology combines mostly anthropology with soil science to study how outsiders to institutional science understand and use soils (Barrera-Bassols and Zinck 2003; Sandor and Furbee 1996).
2. This is a much wider application of the term, as “biomantle” is usually reserved for “material sorted and brought to the surface by animals” (Schaetzl and Anderson 2006, 242).
3. Clay is a particle size category with a diameter of less than 2 μ. Humus refers to highly decomposed OM that is relatively stable (it cannot be easily broken down further), sometimes for millennia.
4. These kinds of sediment alterations, however, have not been noted in the case of other bottom-dwelling life forms, like algae. Even though there are plenty of such organisms that live under water at greater depths, such as ocean bottoms, the material on which they grow provides little more than anchoring. There is no development of differentiated layers (horizons) as a result of organisms’ activities and those other forces above and below the interface between the water and the material at the bottom of the body of water. And the nutrients that such plants require are mostly provided through minerals and organisms in the surrounding water, much like a soil-less hydroponic solution. Or, at least, none of these effects have been demonstrated yet in the case of environments below 2.5 m of water. Perhaps this will change in future and the extent of soil cover could reach ocean bottoms.
5. The inclusion of organisms as one of the main factors implies that soil scientists should resist the notion of Martian soils (that is, until life forms are found and shown to be contributing to pedogenesis).
6. Prevailing soil-formation models oscillate between stressing either factors or processes or both. More recently, some have forwarded the notion of evolutionary pathways, which can feature a range of possible outcomes in soil characteristics, but this reappraisal of soil formation retains the distinction between factors and processes in spite of the focus on evolutionary trajectories. Still, it is a marked departure from a steady-state or equilibrium view (Johnson and Watson-Stegner 1987; Schaetzl and Anderson 2005, 320–342).
7. This “mobile topsoil” view is predicated on a restricted understanding of parent material as original substrate. There should instead be a source-based differentiation. Thus, one can more effectively address the dynamism of soil formation by explaining a lack of influence of lower-lying parent material as outcome of new parent material additions (e.g., compounds introduced through rainwater and settling dust), rather than a break in the relationship between lower-lying original material and the over-lying soil. The consequence of this could be to rethink the concepts of factors and processes along a more

dialectical understanding, whereby the status of factors as outcomes or processes depends on scale of analysis.

8. This is the Natural Resources Conservation Service of the USDA. There is also a very informative web site available on anthropogenic soils; see http://clic.cses.vt.edu/icomanth/, accessed January 21, 2009.
9. He even argues that human impact can be independent of the other factors, a clear exaggeration, since even in the manufacturing of compost and topsoil, other organisms are necessary to produce OM and the necessary resources to produce compost and topsoil (e.g., fossil fuel energy, water, mineral materials) depend on often thoroughly nonhuman processes for their existence.
10. There are also many other organisms that could be excluded on account of their limited influence, such as almost all bird and mammalian species.
11. The authors do not even seem aware of the possibility that genetics and cultural practices may be mutually constitutive. For instance, "body weight, sickness and health, and work being done" are treated as "initial human genotypes" (Amundson and Jenny 1991, 101), which denies, just to mention one illustration, the possibility of people's body weight being influenced by hunger imposed through low wages or forced displacement.
12. For instance, the number of social categories within Great Plains Indigenous Peoples is correlated with climate and soil fertility, but the social structures of Spanish, French, and British/US colonizers are somehow immune to such correlation and no attempt is made to investigate historical changes in Indigenous Peoples' social categories and the effects of relationships between different peoples.
13. But they are problematic even on their own terms. There is no possibility, for example, of discerning impacts even at the most generic level. A *plaggen* soil (*Anthrosol*) could be the product of an urban garden in the present as much as it could be due to OM inputs from centuries ago. The concept of *Technosol* dissimulates differences between cities, not all of which, for example, are industrialized. The USDA system is an attempt to maintain existing categories without formulating special ones highlighting human impact. Instead, sub-categories are used on the basis of recognizably human-altered horizons. However, by using this system one is forced to reproduce virtually the same inaccuracies and false dichotomies (farming/urban, industrial/"natural").
14. Among the first institutional systems was the Russian zonal (climate-centered) soil classification, which influenced the development of US soil taxonomy, among others, but the US system has become increasingly an international standard rivalling that of the FAO. Preferring one over the other can be for technical reasons, since the

US classification system bears some limits with respect to certain broad soil types. For example, the Canadian and UK classification systems are much more attuned to wetland soils.

15. This does not mean there is no reality outside social or human-made reality; classifying soils or other environmental phenomena already presumes engagement with nonhuman reality and trying to make sense of it.
16. This process is also known as "aridification," when human-induced, and as "ripening," when due to nonhuman causes (Gerrard 2000, 60–61, 199).

CHAPTER 3

1. There are many characteristics of soil particles besides average diameter. For example, they have different kinds of surface texture, such as the degree of etching pits, scratches, and coatings. They come in various shapes, such as different degrees of roundness, angularity, sphericity, flatness, and other geometric properties. Measures and indices derived from particle surface and geometry analysis can indicate the prevailing type of weathering or the origins and alteration of the material that contributed to making a soil (FitzPatrick 1993; Ringrose-Voase and Humphreys 1994).
2. The reason for considering only these particle sizes is because it is thought that the coarser fraction (e.g., gravel, cobbles) does not exhibit characteristics of soil material or processes. There are also different ways of categorizing particles and, in fact, there are several systems in use. The most influential ones are those of the International Soil Science Society (ISSS), USDA, and the former USSR. The differences are not trivial. What is gravel or clay in the US could be taken as stones or fine silt respectively in Russia. If one is describing fine sand according to the ISSS, it could really mean coarse silt for someone else using the USDA scheme. This further affirms the point in Chapter 2 about the social basis of defining and describing soils. In different social settings, there can be different ways of breaking down innumerable or seamless objects (like particle types or sizes) into a few generalizations or categories and of understanding what is and is not part of a soil.
3. Another way of saying the same thing is that if one fills a cup with clay-size grains, there will be many more pores between those particles than if the same cup were filled with sand-size grains. The pores between the sand-size grains will certainly be larger, but there will be much less of them compared to the number of pores among clay-size grains. This is because one can fit many clay-size particles in the equivalent volume of one sand-size particle.

4. pH is a logarithmic scale from 0 to 14 that refers to the molar amount of H^+ (technically, H_3O^+) in a solution. It is measured as $-\log[H_3O^+]$, where brackets denote moles (on moles, see note 6 below, this chapter). Each unit difference represents a ten-fold increase or decrease in moles of H^+. For example, $pH4 = (10^{-4}\,mol/L)(10^6\,\mu mol/mol) = 100\,\mu mol/L$, while $pH\,5 = 10\,\mu mol/L$. A pH of 7 is neutral. Above that value, a solution is said to be alkaline. Below pH 7, a solution is regarded as acid. In other words, the greater the amount of H^+, the lower the pH will be.
5. Ions are atoms that tend either to give electrons to other atoms (anions, negatively charged) or to attract electrons from other atoms (cations, positively charged). When ions are called anions, it means they have a negative charge because they have more electrons (negatively charged sub-atomic particles) than protons (positively charged sub-atomic particles). The converse is true of cations.
6. A mole is the atomic mass of an element or compound (e.g., 1 mole of hydrogen is 1 g; 1 mole of calcium is 40 g). For ease of calculation (mole units can get very large), millimoles (0.001 moles) and centimoles (0.01 moles) are often used. Moles of charge (mol_c) refer to ions' positive or negative charge and a mole of charge of any ion is equivalent to a mole of charge of any other ion. The magnesium ion (Mg^{2+}), for example, has two moles of charge per mole and has twice the moles of charge of hydrogen (H^+), which has only one mole of charge.
7. The main chemically reactive particles are humus, mineral clays, iron and aluminum oxides and hydroxides, and carbonates. They come in different shapes and sizes and specific surface areas. Importantly, they differ in the amounts, type, and distribution of charge on their surfaces. For example, OM can reach a CEC of 3,000 meq/kg and the clay minerals montmorillonite and illite have respectively a range of 80–150 and 10–40 meq/kg (Gerrard 2000, 42).
8. Water-soluble salts include but are not limited to sodium. They are ions that, when combined, can form neutral (uncharged) molecules. So, measuring soil salinity means the sum of charged elements or compounds like calcium, magnesium, potassium, carbonates, and sodium.
9. For example, there is an inherent pretense to industrialized farming that the differing qualities of soils over the same land area can be overcome through the use of fertilizer, liming, and other additions.
10. The authors then inexplicably offer a functional equation only for agriculture and forestry: $S_q = f(P_i, S_c, R_d, e_d, N_c, B_d)_t$, where soil quality is a function of productivity (P_i), structure (S_c), rooting depth (R_d), charge density (e_d), nutrient reserves (N_c), and soil biodiversity (B_d), over time (t). This formula hides more than it reveals. The evaluation of P_i and N_c are obviously going to differ according to overall

production objectives and economic pressures. Management and land use decisions are not givens, as intimated through the formula.

11. This process resembles the intimate link between soil science and state institutional discourse and practices I explored in the case of Hungary, where soil scientists began regarding soils as capital during the period of integration into Western European economic orbits, starting in the late 1960s (Engel-Di Mauro 2006).
12. See http://www-pub.iaea.org/iaeameetings/41176/International-Conference-on-Managing-Soils-for-Food-Security-and-Climate-Change-Adaptation-and-Mitigation.

CHAPTER 4

1. To some extent the maximum-yield notion is the soil and agronomic sciences' version of what some have called productivism or, in blatantly U.S.-centred, modernist (stagist) terminology, "Fordism" (e.g., Goodman and Redclift 1991; Ilbery and Bowler 1998).
2. On the other hand, if soil scientists are intentionally using terms like productivity according to prevailing bourgeois meanings, then judging soils according to production efficiency and abstract (disembodied, ahistorical) preferences shifts the focus of analysis from soils to input-output ratios and the satisfaction of human wants (and the preferences of only those that have the money to count in the market). In the process, soils are reduced to vehicles for transfers of matter and/or energy, with quantitative assessments of what is ironically not in soils themselves but what flows through them. Adding concepts like utility only exacerbates the problem (e.g., whose preference for what, whose satisfaction and satisfaction of what?).
3. The Assessment involving a collective of 1,360 experts treats soils and water systems in passing and as of secondary importance, relegated to the status of "supporting services."
4. ISRIC, housed in The Netherlands and known as the International Soil Museum until 1984, was established in 1966 with UNESCO and Dutch government support to serve as international soils information clearing house. It largely represents the mainstream of the International Society of Soil Sciences (http://www.isric.org). The IIASA, based in Austria, comprises representatives of national scientific organizations from 20 countries (mostly the upper ranks of the OECD member states) who decide on research priorities (http://www.iiasa.ac.at/).
5. Degraded land was deemed 1,965 million out of a total of 4,833 million hectares of farmland (305 million hectares irreversibly damaged, relative to agricultural purposes). According to the study, water and wind erosion, chemical deterioration (e.g., salt and pollutant accumulation, acidification), and physical degradation

(e.g., compaction) respectively affected 1,643, 239, and 83 million hectares.

6. See also http://www.isric.org/projects/global-assessment-human-induced-soil-degradation-glasod. Lindert (2000) critiques GLASOD for providing overall diachronic figures (1945–1990) without there ever having been a prior global assessment. In this, however, he is mistaken (Bot, Nachtergaele, and Young 2000; FAO 1979).
7. http://www.isric.org/projects/land-degradation-assessment-drylands-glada.
8. Irritatingly enough for a geographer is the use of the Mercator projection, which distorts area in proportion to distance from the equator. The authors' justifying the use of the projection as giving "the least distortion of the continents" (Oldeman and van Lynden 1996, 5) does not inspire much confidence about competence. Given the contested nature of the Mercator projection within the UN (Monmonier 2004), the authors' selected projection is even less self-flattering. With the HWSD, it is possible to display information with more appropriate projections.
9. There are, among others, the Soil and Terrain Database (SOTER) Programme, concurrent with and the next stage of GLASOD, the World Inventory of Soil Emission Potentials (WISE), and the above-mentioned HWSD.
10. http://www.fao.org/globalsoilpartnership.
11. http://www.isric.org/projects/land-degradation-assessment-drylands-glada.
12. http://www.fao.org/nr/lada/index.php?option=com_content&view=article&id=175&lang=en&Itemid=126.
13. http://www.thegef.org/gef/node/ 3945.
14. It is sometimes unclear if it is only about human life, as the authors are not consistent on the issue (see Oldeman, Hakkeling, and Sombroek 1990, 7).
15. http://www.worldwatch.org/taxonomy/term/751, http://www.worldwatch.org/node/5820.
16. The organization, with no supporting evidence, claims half the world's topsoil has disappeared over the past century and a half; see http://worldwildlife.org/threats/soil-erosion-and-degradation.
17. http://eusoils.jrc.ec.europa.eu/themes.html.
18. http://www.fao.org/nr/land/degradation/global/en/.
19. Figures are herein converted from figures in t ha^{-1}, assuming bulk density of 1.3 t m^{-3}. This yields an equivalence of 13 t ha^{-1} per mm of soil loss.
20. For example, movement of material from polluted soils (e.g., as mine spoil), for example, can lead to chemical degradation downslope.
21. http://www.ars.usda.gov/Research/docs.htm?docid=5971.
22. Montgomery also implicitly underestimates catastrophic events causing accelerated erosion and magnifying human impact, such as

earthquake-generated landslides, which can remove entire soils (like mining and quarrying, which should be also viewed as human-induced catastrophes of industrialized capitalist societies). The average or median geological erosion rates are over millions of years. Extreme events may be diluted over long time intervals than in the case of farming, which ranges over thousands, not millions of years. It is possible that during intervals of several thousands of years in geological epochs, prior even to human existence, global average soil erosion rates may have been similar or even higher. However, periods of relatively high erosion rates would be masked by the averaging of figures over millions of years. For more appropriate comparisons, one should ascertain the geological erosion peaks at millennial intervals and account for cataclysmic events to make the data comparable to the thousands of years since agriculture first emerged. Given available data, it is premature to state that agriculture promotes higher erosion rates comparable to those occurring in steep slopes (alpine erosion rates).

23. Net Degradation = (Natural Degradation + Human Induced Degradation) – (Natural Recovery + Human Improvement).
24. Lal's model is as follows: $S_r = S_a + \int_{ti}^{tf} (Sn - Sd + lm)dt$, where S_r is soil resilience, S_a is antecedent soil conditions, S_n is new soil formation, S_d is the rate of soil degradation, and I_m stands for anthropogenic inputs external to the ecosystem.
25. This is the equation I = PAT that was developed out of the work of Ehrlich and Holdren in the early 1970s (York, Rosa, and Dietz 2003), where I = environmental impact, P = population, A = per capita affluence, and T = impact per unit of technology. Paraphrasing Hynes, the formula can be rewritten as I = C-PAT and the terms redefined as P = patriarchy, A = global resource consumption resulting from relations of domination, and T = environmentally damaging uses of technology, with C representing ecologically constructive impacts (similar to Blaikie and Brookfield's "Human Improvement").
26. If a community is characterized by oppressive relations of power and resources are distributed in a highly unequal manner, then, just as in the case of any political endeavor, one needs to find out why and, on the basis of that knowledge, decide what to do to contribute to making for an egalitarian set of relations. To state the obvious, there are no predetermined ways of intervening to change society.

CHAPTER 5

1. Field experiments are one way in which soil scientists combine use and the more distancing lab study of soils, for instance, but farmers, too, study soils (as evident, e.g., in their classification systems) while at the same time, unlike the vast majority of soil scientists, they depend on soils for their livelihoods. The circumstances and aims differ (and

consequently so does the sort of knowledge produced), but they are all studying soils and systematizing the knowledge they produce out of their interactions with soils. As Stocking (2003, 1358) observes, "Farmers may often make better decisions than the 'experts,' not because of any greater analytical skills, but because of the experience gained in integrating a vast array of local factors responsible for controlling production."

2. Thus, as in a cycle of recycling clichés, we regress to a moralistic story of people getting uncontrollably salacious upon having more food available, over-copulating (apparently few know about birth control), then seeking to produce more food on less land to overcome the outcome of their sexual urges, leading to bad land use and eventually to the demise of the species.
3. Milpas are systems of community integration that involve often highly biodiverse intercropping, cycles of cultivation and fallow, and sometimes permanent forest clearings. The socially integrative aspects and the sometimes militarized encroachments forcing peasants into forests are usually lost to soil scientists, who resort to populationist arguments to explain deforestation.
4. For example, the nutrient data exclude non-commercial inputs and urban farming.
5. Arguments pointing to demographic expansion as driving human-induced soil degradation in antiquity are also predicated on misinterpretation of archaeological evidence. This is clear from the example of wild discrepancies between estimates on ancient Maya demographics. To Montgomery (2007a, 74), the Maya population grew to three to six million by 800 C.E., then declined never to recover again to such numbers. According to Sharer (2009, 514), it reached tens of millions. This discrepancy is due to scant research on the majority of ancient Mayan peoples, the "commoners," in addition to significant uncertainties traceable to the unevenness of archaeological records (housing structures, pottery shards, and other remains) and the questionable assumptions made about population dynamics, such as cross-generational family size homogeneity. For these reasons alone, population estimates should be considered context-specific (Sharer 2006, 97, 685–690), not comparable across continents.
6. http://www.eea.europa.eu/articles/urban-soil-sealing-in-europe.
7. http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Population_and_population_change_statistics#EU-27_population_continues_to_grow.
8. Livestock and forestry are sometimes called into question, too, but usually it is cropping systems that are usually considered the main culprits, with other kinds of food provisioning systems (e.g., gathering) simply ignored.
9. See http://monthlyreview.org/author/fredmagdoff.

10. Much of the study is based on data from the Calhoun experimental forest (South Carolina, US), established in 1947.

CHAPTER 6

1. http://www.marxists.org/subject/dialectics/marx-engels/anti-durhing.htm.
2. Some also have a different understanding of ecology, which is often conflated with nature or environment. To the archaeologist Sharer, for example, ecology refers "to the relationships between societies and their environments" (Sharer 2009, 39). Apparently, some are unaware that the human species is but one among millions (Mora et al. 2011). It is not that a single definition of ecology should exist, but that claims about addressing nonhuman processes should at the very least study subjects that are not confined to social relations. Otherwise, it would be less deceptive to call such studies for what they are, studies of social relations and no more.
3. This is only made worse by focusing on a controversial hypothesis proposed by a single researcher, Ruddiman, according to whom long-term climate change has been shortened by human-induced CO_2 emissions. Rather than raise the credibility of an argument about society and climate change, selecting the more convenient hypothesis, without addressing alternative hypotheses, only debilitates it.
4. The issue also became a matter of soil erosion, rather than hindrance to irrigation systems (Bennett 1939, 916–920).
5. Since the introduction and diffusion of synthetic fertilizer and industrialized liming, the problem is even more of nutrient overload. It is anachronistic to insist on soil depletion, as Foster does, rather than landscapes depleted, or, rather, gouged by rock phosphate and potassium mining and natural gas drilling (to produce nitrogen fertilizers). But there is more to this than anachronism. Metabolic rift fails to distinguish between soil phosphate depletion and enrichment, since the process is treated as if it did not matter ecologically where those processes are occurring. For instance, even if one were to accept phosphate enrichment as the waste side of metabolic rift (due to phosphate mining), it is debatable whether a balance of nutrient flows is generally interrupted by capitalist farming. The matter is context-dependent. For instance, ecosystems on phosphate-poor soils can benefit from such additions, provided phosphate is plant available.
6. In admittedly weak defense, one could surmise that there are different rifting rates (Salleh 2010, 206). A capitalist metabolic rift is therefore much greater, if not fatal, compared to one from a tributary and slavery-based system like the Roman Empire. However, this line of reasoning does not allow for past rifts to be constitutive of subsequent ecological dynamics because rifts are taken as phenomena to be

repaired, not as processes of ecological change. Regardless, the error of presuming homoeostasis remains unaffected by this.

7. Moore's use of "ecological fix" (Moore 2010a, 3, 5) to explain capital expansion also makes a bit of a mockery of David Harvey's concept of spatial fix, which results from social struggles, rather than social "exhaustion."
8. Meggers' argument is misplaced regardless, unless one pretends, for example, that people living in Amazonia in antiquity had already invented chainsaws, explosives, mining machinery, and were involved in intense, high-volume, profit-oriented trade.
9. See http://www.fao.org/nr/land/soils/digital-soil-map-of-the-world/en/.
10. See http://minerals.usgs.gov/minerals/pubs/commodity/lime/mcs-2012-lime.pdf.
11. As depletion and exhaustion are used interchangeably by most to mean the loss of nutrients or soil fertility, the two concepts are treated in the same manner here.
12. See an excerpt of his intervention at the 2013 Annual Meeting of the American Agronomy, Crop Science, and Soil Science, https://www.agronomy.org/news-media/releases/2013/1014/610/.
13. To turn clayey into sandy texture implies the introduction of sand or some other process that changes overall particle size distribution. Perhaps, unbeknownst to soil scientists, grasses have discovered the means to transport large piles of sand and mixing them into soils so as to conquer forests, which, incidentally, can also thrive on sandy soils, depending on the tree species and the rest of the soil properties and processes thoroughly ignored by Latour.
14. One could also ask whether the researcher is even a possibility in actor-networks. If a researcher exists on a par with the cells (or subatomic particles) that comprise that researcher, it might also make for a horrific end to the researcher if the cells decide to split (but why do they not, if they have the same degree of agency?). In the desperate quest to end the nature–society split, actor-network theorists seems to have forgotten to check their own roles in the networks they construe.

CHAPTER 7

1. This could even be phrased as starting from but going beyond Marx (1845, 149; 1867, 174) in recognizing the biophysical basis of society and studying it as well.
2. Dichotomous here means that people and the rest of nature are viewed as split. Dualistic refers to treating society and nature not only as separate (dichotomized) but also as in a relationship of superiority or inferiority to each other (Merchant 1980; Plumwood 1993).

3. Even where some claim “second nature” prevails, human impact is only one part of many processes. For example, manufactured soils involve nonhuman processes, such as microbial activities and the outcomes of biophysical processes in the composition, availability, size, and distribution of mineral particles.

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