Disaster Risk Reduction
Methods, Approaches and Practices

Michiko Banba
Rajib Shaw *Editors*

Land Use Management in Disaster Risk Reduction

Practice and Cases from a Global Perspective

Springer

Disaster Risk Reduction

Methods, Approaches and Practices

Series editor
Rajib Shaw, Integrated Research on Disaster Risk (IRDR), Beijing, China

About the Series

Scope of the Series

Disaster risk reduction is a process, which leads to the safety of community and nations. After the 2005 World Conference on Disaster Reduction, held in Kobe, Japan, the Hyogo Framework for Action [HFA] was adopted as a framework of risk reduction. The academic research and higher education in disaster risk reduction has made/is making a gradual shift from pure basic research to applied, implementation-oriented research. More emphasis is given on the multi-stakeholder collaboration and multidisciplinary research. Emerging university networks in Asia, Europe, Africa and the Americas have urged for the process-oriented research in disaster risk reduction field. Keeping this in mind, this new series will promote the outputs of action research on disaster risk reduction, which will be useful for a wider range of stakeholders including academicians, professionals, practitioners and students and researchers in the related field. The series will focus on some of the emerging needs in the risk reduction field, starting from climate change adaptation, urban ecosystem, coastal risk reduction, education for sustainable development, community-based practices, risk communication, human security, etc. Through academic review, this series will encourage young researchers and practitioners to analyse field practices and link it to theory and policies with logic, data and evidences. Thus, the series emphasizes evidence-based risk reduction methods, approaches and practices.

More information about this series at http://www.springer.com/series/11575

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Preface

Land use has been regarded as a key factor in environmental management including disaster management. Land use planning is expected to play an important role in sustainable development. Managing land use is a broader concept to combine and utilize various measures to achieve purposes through control, supervision, or handling. It is not limited to a compulsory approach but is an autonomous approach to guide behaviors on decisions of people or companies. Thus, land use management is a flexible method to fit the existing social and economic system.

Land use management can be a useful tool not only for urban and regional development but also for disaster risk reduction. However, it is not utilized so much because of the complexity in implementation. It needs to be approached from an environmental, social, economic, or psychological perspective. Land use management also implies administrative and legal systems that are connected to social and economic activities. Land use management should be considered at the national and local government level to develop legal systems, policies, and concrete countermeasures for its implementation. At the same time, governments need to make efforts to raise risk awareness of citizens through risk communication. Hazard information about what can cause disaster risks plays a role in affecting risk perception. The task of governments is to prepare a comprehensive framework to actualize land use management together with risk communication with citizens.

This book includes a collection of 21 case studies and practices from the perspective of land use and land use management in the context of disaster risk reduction in various countries and regions. These are from academic institutes, local governments, higher education institutes, NGOs, and the private sector, which practice land use management, or are from land use contexts in the disaster management field.

This book is written for students, researchers, and practitioners in the fields of disaster risk reduction. We hope they will find it useful and relevant to their work.

Kobe, Japan Michiko Banba
Beijing, China Rajib Shaw

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Rajib Shaw was a professor in the Integrated Research on Disaster Risk (IRDR), Beijing, China. He worked closely with local communities, NGOs, governments, and international organizations, including the United Nations, especially in Asian countries. He is currently the cochair of the United Nations Asia Science Technology Academia Advisory Group (ASTAAG) and the president of the Asian University Network of Environment and Disaster Management (AUEDM). His research interests are community-based disaster risk management, climate change adaptation, urban risk management, and disaster and environmental education. He has published several books in the field of disaster and environmental management and is also the chief editor of the *Asian Journal of Environment and Disaster Management*.

Part I
Introduction

Chapter 1
Land Use Management in Disaster Risk Reduction: An Overview

Rajib Shaw and Michiko Banba

Abstract Land use has a natural implication, where there are synergies of different ecosystems. However, with human interventions, there are often changes in land pattern, and land use management comes into existence. Several global frameworks like Sustainable Development Goals, Paris Agreement of climate change, and Sendai Framework for Disaster Risk Reduction (SFDRR) have emphasized the importance of incorporating land use planning in development issues, climate change issues, and disaster risk management approaches, respectively. However, the challenge remains in implementing the local level land use planning and management, which needs community ownership and involvement as well as local government's strict guidelines and monitoring of land regulations.

Keywords Land use • Land management • SDG • Paris Agreement • SFDRR • Local implementation

1.1 Introduction

People's connection to land goes back to its roots. With the growth and development of mankind, land use started changing from natural to human induced. While with the population growth, the demand for land increases; however, there is always a fixed amount of land available. Ideally, what used to be natural balance of land use and land management under different ecosystem has now become a human-induced trigger. The extreme increase of land sales and land leases in developing countries

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illustrates that the global competition for scarce land resources has gained a new dimension. In modern days, land use involves the management and modification of natural environment or wilderness into built environment such as settlements and seminatural habitats such as arable fields, pastures, and managed woods. Land management is the process of managing the use and development (in both urban and rural settings) of land resources. Land resources are used for a variety of purposes, which may include agriculture, forest, water resource management, industrial and housing development, etc.

Historical record shows urbanization has induced land use changes from agriculture or forestland or vast coastal areas to built environment. Due to pressure of economic growth, these changes have been quite rapid, abrupt, and in most cases non-planned. This created new vulnerability but exposing the built assets and infrastructures to different types of natural hazards, be it in coastal, mountain, or river basin areas. After a disaster, there are new land use regulations imposed in several places. For the coastal disasters, usually, a strict coastal land use regulation is imposed or reimposed with strict boundary condition. For urban areas, new urban development zonation is formed. For mountain disasters, strict slope regulations come into existence. These regulations provide a temporary brake to the fast development pathways. However, over a period of time, in many instances, practices go back to the conditions existed before the disaster, and therefore creating new risks. Thus, a viscous cycle is formed of development, land management, exposed risk, disaster event and new land management, etc.

In this chapter, a brief attempt is made to provide a link of land use management and disaster risk reduction, in terms of global frameworks, policy, and practice.

1.2 Land Use Planning, Management, and Development Frameworks

Land use planning presents a development approach that contributes to the prevention of land use conflicts, the adaptation of land uses to physical and ecological conditions, the lasting protection of land as a natural resource, and the lasting productive use of land and a balanced use that fulfills all social, ecological, and economic requirements. "Land use planning creates the preconditions required to achieve a type of land use that is environmentally sustainable, socially just and desirable, and economically sound. It thereby activates social processes of decision-making and consensus building concerning the utilization and protection of private, communal, or public areas."

At the core of land use planning is the joint balancing of competing land uses by all stakeholders (users and those affected from the (changes in) land uses) and the joint identification of those uses for which the highest consensus can be achieved—ideally for the purpose of sustainability. The use of adequate, locally adapted information systems providing information on, for instance, land availability, existing land rights, and land uses can create transparency at national and decentralized levels. This transparency is an important base for all further planning and responsible decision-making on the use of land (GIZ 2012).

1.2.1 Land Use and Sustainable Development

Agenda 21 resulting from the United Nations Conference on Environment and Development (UNCED) in 1992 in Rio de Janeiro was the first international document highlighting the importance of land use planning for sustainable development. Although the Rio Declaration was not legally binding, Agenda 21 has been adopted by many countries and adapted to their specific contexts—often at national, regional, and local level. Agenda 21 processes have given an important impulse to land use planning as they focus on participatory planning and action at local level to achieve sustainable development.

Keeping pace with the urgency for progress on the fronts of SD, CCA, and DRR, the year 2015 has been a landmark year in the history of development, disaster, and environment fields, where three major international frameworks have been formed. The year started with adopting a new DRR framework in March 2015 in Sendai, Japan, called Sendai Framework for Disaster Risk Reduction (SFDRR) with a time frame of 2015–2030 (UN 2015a). Then, there was a new set of development goals called Sustainable Development Goals (SDG) with the same time frame of 2015–2030, which was adopted in the UN General Assembly in New York in September 2015 (UN 2015b). Finally, the world leaders agreed on a new climate change agreement called Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC), which needs to be ratified between April 22, 2016 and April 21, 2017 (UN 2015c).

Sustainable Development Goal 15 of the 2030 Agenda aims to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss." Promoting the sustainable management of forests and halting deforestations is also vital to mitigating the impact of climate change. Urgent action must be taken to reduce the loss of natural habitats and biodiversity, which are part of our common heritage. The economic and social significance of a good land management, including soil and its contribution to economic growth and social progress, is recognized in paragraph 205 of the Future We Want. In this context, member states express their concern on the challenges posed to sustainable development by desertification, land degradation, and drought, especially for Africa, LDCs, and LLDCs. At the same time, member states highlight the need to take action at national, regional, and international level to reverse land degradation; catalyze financial resources, from both private and public donors; and implement both the United Nations Convention to Combat Desertification (UNCCD) and its 10-year strategic plan and framework (2008–2018).

1.2.2 Land Use and Climate Change

The UN Framework Convention on Climate Change (UNFCCC) recognizes the role that agriculture and forestry can play in climate change mitigation. Mitigation can be achieved through activities in the land use, land use change and forestry (LULUCF) sector that increase the removals of greenhouse gases (GHGs) from the atmosphere or decrease emissions by sources leading to an accumulation of carbon stocks. An important feature of LULUCF activities in this context is their potential reversibility, hence, nonpermanence of the accumulated carbon stocks.

However, UNFCCC does not have a coherent set of requirements and incentives for reducing emissions from the land use sector as a whole—also referred to as the agriculture, forestry and other land use (AFOLU) sector (CLP 2015). The UNFCCC traditionally adopts risk-based approach to protect the social and environmental integrity of mitigation actions from the land use sector, but such approach is largely insufficient to achieve this objective. The example of REDD+, which includes safeguards that require countries to be more pro-active in enhancing governance, rights, and biodiversity, could potentially stimulate a shift toward a view of social, environmental, and governance provisions as "enabling conditions" for effective and sustainable climate actions.

Article 5.1 of the Paris Agreement puts in place an expectation that parties should take action to "conserve" and "enhance" sinks and reservoirs of greenhouse gases including biomass, forests, and oceans as well as other terrestrial, coastal, and marine ecosystems. This provision restates the content of Article 4 of the Climate Convention and, read in the context of the new Agreement, now opens up questions as to how "conservation" and "enhancement" of these ecosystems can contribute to achieving the long-term goal of limiting global warming to well below 2 or 1.5°. It calls for ways by which these carbon sinks and reservoirs can contribute to achieving the 1.5° target and opens a discussion about the importance of safeguarding these ecosystems. It arguably puts in place a legal basis to require countries to "conserve" and "enhance" ecosystems when taking actions related to climate change.

CLP (2015) argues that land use needs more integrated approach along with governance, rights, biodiversity, etc. It says that the 2015 Agreement must provide direction to countries to ensure a more integrated approach to land use management, so that policy can be developed in a balanced, rational manner. If it fails to do this, there are significant risks that mitigation actions in the land use sector will lead to negative impacts on key ecosystem/landscape values/services, such as ecosystem resilience (and therefore adaptation), livelihoods, and food security.

1.3 Land Use and Disaster Risk Reduction Frameworks

The DRR concept has evolved over the last 25 years. With the first UN resolution in 1985 to establish the International Decade for Natural Disaster Reduction (IDNDR) from 1990, it evolved to the establishment of International Strategy for Disaster

Reduction (ISDR) from 2000. The first global framework on DRR was established in 2005 as the Hyogo Framework for Action (HFA), with five priorities: (1) institutionalize DRR efforts; (2) identify, assess, and monitor disaster risks; (3) use knowledge, innovation, and education to build a culture of safety; (4) reduce underlying risk factors; and (5) strengthen disaster preparedness for effective responses. Among these priorities, number 4 (underlying risk factors) focuses entirely on development issues (poverty, sanitation, health, etc.) and also links to the climate change impacts. HFA priority 4 emphasizes incorporating land use planning and regulations to reduce risk factors. Since then modest progress has been made on planning regulations in some countries, especially for earthquake risk. Seismic micro-zonation is regarded to be a successful tool for better land use planning in urban areas. Even though reducing risk through land use planning and building codes has not been as effective as advances in national legislations, risk assessments, and preparedness, it can inform all urban infrastructure projects.

Sendai Framework for Disaster Risk Reduction (SFDRR) was adopted in 2015 in the World Conference on Disaster Reduction (WCDR) in Sendai, Japan. SFDRR has four priority areas: (1) understanding disaster risk, (2) strengthening disaster risk governance to manage disaster risks, (3) investing in disaster risk reduction for resilience, and (4) enhancing disaster preparedness for effective response and to "build back better" in recovery, rehabilitation, and reconstruction. There are seven global targets: (1) reduce mortality, (2) reduce number of affected people, (3) reduce direct disaster economic losses, (4) reduce critical infrastructure disruption, (5) increase number of countries with national DRR strategy, (6) enhance international cooperation for actions, and (7) increase access to multi-hazard early warning system.

Priority 2 of SFDRR focuses on land use issues to encourage the establishment of necessary mechanisms and incentives to ensure high levels of compliance with the existing safety-enhancing provisions of sectoral laws and regulations, including those addressing land use and urban planning, building codes, environmental and resource management, and health and safety standards, and update them, where needed, to ensure an adequate focus on disaster risk management.

Priority 3 focuses to promote the mainstreaming of disaster risk assessments into land use policy development and implementation, including urban planning, land degradation assessments, and informal and nonpermanent housing, and the use of guidelines and follow-up tools informed by anticipated demographic and environmental changes.

Priority 4 focuses to promote the incorporation of disaster risk management into post-disaster recovery and rehabilitation processes; facilitate the link between relief, rehabilitation, and development; use opportunities during the recovery phase to develop capacities that reduce disaster risk in the short, medium, and long term, including through the development of measures such as land use planning, structural standards improvement, and the sharing of expertise, knowledge, post-disaster reviews, and lessons learned; and integrate post-disaster reconstruction into the economic and social sustainable development of affected areas. This should also apply to temporary settlements for persons displaced by disasters. Priority 4 also emphasizes on developing guidance for preparedness for disaster reconstruction, such as on land use planning and structural standards improvement, including learning from the recovery and reconstruction programs over the decade since the adoption of the Hyogo Framework for Action and exchanging experiences, knowledge, and lessons learned.

Thus, the SFDRR urges the national and local governments to develop policy guidelines on land use and implement the land use measures on the ground, respectively. Land use planners are urged to engage centrally in disaster risk reduction. However it is not the primary activity of planners to practice hazard mitigation. It is at best a minor or subsidiary role in a profession, which is primarily concerned with the development of land for new uses, especially urban growth. Responsible land use planning can prevent or reduce the severity of impact that a natural hazard can have upon a community. Building standards can mitigate the damage and destruction to property and infrastructure and therefore increase the resilience of a community during and after a disaster. These two approaches in combination contribute to the creation of safer and more sustainable communities (King et al., 2015).

1.4 Focus on "Local" Initiatives

Several international frameworks urge for national level rules and regulations and also focus on regional and international negotiations on land management issues. In many countries, rules and regulations for land use and its management do exist. However, the key issue is its implementation, which is done in local level, both at local government as well as local neighborhood and community levels.

A quick analysis of the three frameworks shows emphasis of "local" issues at different levels. The SDG document has mentioned the term "local" ten times in the 35-page document. The term local is used in connection to authorities, communities, culture, materials, and planning. Goals 6, 8, 11, and 13 have more mention of local issues. In Paris Agreement, the term local is used nine times in the 32-page document and is used in connection with communities as well as knowledge. This is mostly relevant to adaptation context. For SFDRR document, local is used for 48 times in 25-page document. It is used with different connections like government, community, knowledge, priority, DRR strategy, etc. Thus, it shows that in case of DRR, possibly the global mind-set is to focus more on local implementation. All the four priorities in SFDRR have explicit national and local context. However, the SDGs and Paris Agreement somehow recognize the importance of local issues, but lack specific details of implementation.

In case of rural context, it is the local ownership of the land and its management practices, which ensure the sustainability of land use management. A traditional community-owned land use management practice exists in Sri Lanka for more than 1,000 years. The key target is indigenous water and land management for sustainable farming in the dry zone areas (Nianthi and Dharmasena 2009), especially to cope with the impacts of the drought in agriculture sectors. Small water reservoirs (village tanks), intricate network of channels, and strict land use are the key to the success and sustainability of tank cascade system. The system is composed of micro land use components based on specific *ecosystem approach*: *Gasgommana* (*naturally grown* vegetation in the upstream land strip), *Perahana* (the meadow developed under *Gasgommana* and filters the sediment flow coming from upstream land), *Godawala* (a man-made water hole to trap sediments and provides water to wild animals), *Wew-pitiya* (deep area of the water body, which accommodates a major part of the tank water and is covered with water for more than 8 months in a year), *Mada-kaluwa* (the portion of the water mass found during dry months of the year and located close to the tank bund), and *Kattakaduwa* (a reserved land below the tank bund), among different other components. Local farmers in arid areas use this micro landscape approach with a strong social cohesion, and the integrated farming system is known as bethma practice, which is considered as truly *participatory and multi-stakeholder*. The approach builds of the *existing integrative systems and initiatives* and is also recognized and supported by local administration.

In case of urban setting, it is the local government's land use regulation policy and its strict implementation. To have a successful implementation of land use policy in urban area, periodic monitoring, community meetings, and public awareness campaign are essential. In most cases, the key challenge is the informal settlements and urban sprawls. In case of informal settlement, land ownership becomes a key challenging issue. In case of urban sprawl, the gradual demarcation of urban, peri-urban, and rural areas and its linkages become the key challenge. However, in case of an urban disaster, there is an opportunity for better land regulations in the redevelopment planning, which becomes easier to implement than in the pre-disaster condition.

1.5 About the Book

With the above background, this book focuses on policies and practices of land use management and its link to disaster risk reduction. The book has 23 chapters and is divided into five parts.

The first part is an overview of land use management and its relation to disaster risk reduction and consists of two chapters. The second chapter provides a deeper insight into the land use issues and its relation to disaster risk reduction with certain focus on risk communication. The next four parts focus on urban, mountain, coastal, and river issues and land use management.

Part 2 has seven chapters and focuses on urban case studies from Japan, India, the USA, New Zealand, Mongolia, and Bangladesh. In case of Japan example, the third chapter focuses on the Great Hanshin-Awaji Earthquake and its aftermath. Recovery of the Kobe has been achieved by city planning measure, such as land readjustment projects, urban redevelopment projects, and district plan. The damaged areas of Kobe have been reformed to be resilient against disasters by widening streets and roads and laying out open space or parks. A similar example of land redevelopment and new zoning plan is provided in Chap. 4 after the Bhuj earthquake of Gujarat, India. The chapter emphasized the importance of process-based and participatory approach for land use zoning in post-disaster scenario. Chapters 5 and 7 focus on New Zealand examples. In Chap. 5, New Zealand's land use management for disaster mitigation is analyzed, and issues are discussed from the perspective of legal and administrative framework. It is found out that understanding of natural hazard and risks to make it useful in land use planning and management to control developments. Chapter 7 analyzes land use changes introduced in the first 4 years of the Canterbury recovery and concludes that a better understanding of impacts a large-scale disaster might have on decentralized, integrated, and deliberative land use planning for risk reduction is necessary. Chapter 6 considers the ways recovery policies after Hurricane Katrina (2005) and Superstorm Sandy (2012) incorporate risk-based land use planning, primarily in the form of residential buyouts as part of housing recovery and potential impacts on affected communities and rebuilding households. Chapter 8 describes the residential areas' risk in Ulanbaatar in Mongolia with specific focus to flash flood through satellite imagery analysis. Chapter 9 covers focuses on integrating disaster risk reduction (DRR) into land use planning in Bangladesh, aiming at sustainable urban development by making land use planning more DRR inclusive. The chapter investigates the integration of DRR with a specific objective to promote risk assessment into land use planning preparation in Bangladesh.

Part 3 has six chapters and focuses on mountain case studies from Pakistan, the Philippines, Japan, India, Nepal, and Taiwan. The Pakistan example of Chap. 10 covers the Swat valley area, which is prone to flood risks. In Swat valley, the chapter found that frequent human encroachments onto the flood channel and absence of land use regulations have been identified as the major factors responsible for heavy flood losses. Chapter 11 examines the landslide disaster experience of Guinsaugon, Leyte, and its implications for land use policy specifically looking at the need to revisit land use policy and the importance of risk-sensitive land use planning and public participation in land use planning after a disaster. Chapter 12 examines current preventive measures against sediment disasters in Wakayama, Japan, focusing on nonstructural preventive measures under the Act on Sediment Disaster Countermeasures. The chapter also discusses how to improve its current nonstructural preventive measures, based on the lesson learned from Typhoon No. 12 in 2011. Citing example and experience of the Uttarakhand disaster of India, Chap. 13 found that unplanned constructions, encroachments, and blockade of surface drainage pose serious threat to the stability of the hill slopes in Nainital. Land use/land cover change studies can help in better developmental planning and in keeping identified vulnerable areas, particularly in the proximity of rivers and in the recharge zone of water bodies, free from human intervention. Chapter 14 provides an interesting analysis on land use, land cover change, climate change, and food security issues of Nepal. It is observed that several land use policies have been formulated for the sustainable agricultural development and to preserve the ecosystem and biodiversity. Chapter 15 shows the changes in land regulation after the Typhoon Morakot in Taiwan. It was observed that in Typhoon Morakot Reconstruction

Special Act, it makes prohibited development at specific areas and insecure areas, for avoiding threatening living safety again in environmental sensitive areas and vulnerable areas. In addition, many countries review the articles of the regional planning law after Morakot to enhance the measures of disaster adaptation and disaster mitigation, including the norm of land use on hillside land and governing in coastal flooding area, expecting to reduce casualties and property losses from disasters through applicable land use strategy.

Part 4 has four chapters and focuses on coastal case studies from Indonesia, India, Japan, Vietnam, and Bangladesh. In Chap. 16, Indonesian case study describes the issues after the Indian Ocean tsunami of 2004. Relocation programs made at the three selected locations faced difficulties due to the land price hikes, and there are some coastal communities who work as fishermen, and this made them difficult to be relocated far away from coastal area. To prevent further uncontrollable land use changes at coastal area, the local government of Banda Aceh and Meulaboh put a strict regulation for the coastal area. Meanwhile, the disaster mitigation-based spatial planning in the Mentawai Islands is still in the process of formulation. Chapter 17 focuses on application of technical tools like remote sensing and geographic information system (GIS) in the analysis of risk in Chennai City of South India, which was hit by major tsunami and several typhoons. In Chap. 18, the authors examined salient points during the reconstruction period in order to ensure security against future disasters and, at the same time, to restore people's lives and local communities lost in the disaster, through observation of land use management in the reconstruction after the tsunami caused by the Great East Japan Earthquake (GEJE) in 2011. Chapter 19 analyzes gap between land use plan (LUP) policies and climate change policies in implementation of mainstreaming climate change issues into LUP in southern part of Vietnam. It also illustrates that the provincial LUC and LUP would focus on economic development rather than disaster risk reduction. Chapter 20 conducted a trend analysis of coastal land use changes in Bangladesh. It highlights the responsible factors behind the coastal land use changes. Further, it examines the impact of coastal land use changes in agricultural production and food and water supply.

Finally, Part 5 has three chapters and focuses on river-related case studies from Europe (the United Kingdom, France), Japan, and Thailand. Chapter 21 provides an analysis of land use planning issues in the United Kingdom and France. It is observed that in both countries, the policy of land use management is still evolving, putting more emphasis on ex ante disaster prevention measures. Although neither the United Kingdom nor France has achieved perfect forms of land use management for flood disaster mitigation, every possible policy instrument is employed in their own unique way, and the best management system is being pursued by trial and error. Chapter 22 provides analysis from Japan. Changes of industrial structures of the region and its influences on land use were analyzed, possible flood control measures were summarized, and issues from the land use perspective are analyzed. Finally, Chap. 23 provides example from Thailand. Land management in Thailand uses three main mechanisms: planning, regulation, and fiscal mechanisms. The limitation of Thailand's current urban planning systems is discussed in this chapter.

It was found that land use planning does not coincide with the changing environmental and socioeconomic conditions. In the chapter, a comparison is also made between the land use change map and the flood maps.

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Chapter 2
Land Use Management and Risk Communication

Michiko Banba

Abstract Land use represents a relationship between natural and urban environment. Land use management is the way of managing land use through regulation and control of developments. Land use management tools are used supplementing hard infrastructure developments. In implementation of land use management, risk communication between public, citizens, and private sectors is important to facilitate the understanding of disaster risks and policies.

Keywords Land use management • Development regulation • Risk communication

2.1 Introduction

Natural phenomenon is not a disaster as long as human beings do not interfere natural environment. In ancient times, human beings had limited interference toward natural environment. However, as the civilization progressed, activities of human beings had become vigorous, and the interference had increased with the increase of developments. Thus interactions between natural and urban environments are not avoidable, and it can cause a disaster. From the disaster risk reduction point of view, interactions between natural and urban environments, which harm each other, have to be avoided or mitigated.

Land use pattern shows a relationship between natural and urban environment. Land use plan is a platform to coordinate and balance natural environment and urban environment (Catlin 1997). Appropriate land use pattern can be realized through planning to reduce disaster risks. It is important to develop urban plans considering the consequences. New Zealand developed the planning framework based on the concept that consequences of developments have to be considered in

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the planning land use (Banba et al. 2004). Risk-based land use planning plays an important role in disaster risk reduction.

Land use management is the way of managing land use to match certain purpose. It includes land use planning and other countermeasures and systems which are related to land use. In the context of disaster risk reduction, land use management is used supplementing hard infrastructure developments. How to use land then are determined by policies considering technologies, skills, or social and economic systems of the countries.

2.2 Land Use Management for Disaster Risk Reduction

As mentioned, land use management is an effective method supplementing hard infrastructure which prevents or reduces forces from natural hazards. In this section, land use management tools and related social systems for disaster risk reduction are discussed.

2.2.1 Land Use Management Tools

Land use management tools have to be developed for the appropriate management of land use. Olshansky listed building standards, development regulations, policies for location of critical and public facilities policies, land and property acquisition, taxation and fiscal policies, and information dissemination as land use management tools (Olshansky and Kartez 1998).

Building standards regulate designs and structure in constructing buildings. It is necessary to require particular designs and structure resistant to specific natural hazards in constructing buildings in the area which is under specific natural disaster risks. For example, the area under the earthquake disaster risks needs earthquake-resistant building codes.

Development regulations usually come with zoning to regulate and control developments and construction of buildings. In each zoning, land use policies are determined considering natural and urban environments and social and economic situations. In some cases, influences of natural hazard are taken into consideration in developing zoning policies. There are other cases to overlay special purpose zone such as disaster risk zone on ordinary zoning to regulate developments.

Policies in planning location of critical and public facilities have to be considered in disaster risks as continuity of functions of those facilities is crucial in not only ordinary times but more in emergency times.

Acquisition of land and property which are exposed to disaster risks is another land use management tool, as it requires public sectors' large amount of budget to purchase lands and properties. Although the acquisition is implemented more in the recovery process because of that reason, there are some small-scale acquisitions due to the avoidance of disaster risks in flooding area or areas under landslide risks.

As mentioned, land use plan can be a platform to develop land use management policies utilizing those tools. In city planning, it is designed as zoning to determine how to use land taking disaster risks into consideration.

Taxation and fiscal policies are measures to lessen burden of public sectors for disaster reduction by requiring private sectors to pay for developments in hazardous area (Olshansky and Kartez 1998). It can be used as incentives to restrain such developments by discounting tax.

Dissemination of information related to disaster risks is fundamental in promoting disaster risk reduction measures. Raising risk awareness of citizens is first step. More countries have started to open disaster risk information to the public through hazard maps, brochures, or website.

2.2.2 Social System Related to Land Use Management

Social and economic systems such as insurance and real estate transaction system are connected to land use management. The United States and England have systems to regulate land use and control developments indirectly through natural disaster insurance. Risk level is reflected in insurance premium, which means the higher the risk, the more expensive the premium. In Japan and New Zealand, hazard information needs to be explained in real estate transaction system. When people buy lands or properties, information about geotechnical aspects or disaster risk zoning have to be explained to buyers. It is determined by law.

2.3 Communication

2.3.1 Risk Awareness and Hazard Information

Risk awareness is the fundamental for risk-aversive behavior including the practice of land use for disaster risk reduction. It is important to understand disaster risk correctly. Risk awareness is affected by information of hazard which can cause disaster.

The social system and legal framework for appropriate land use plan and development control is essential to make land use management effective to reduce disaster risks. However, the system and legal framework themselves are not good enough for the implementation of land use management. Governments or municipalities should motivate and lead citizens and developers to practice appropriate land use through laws or incentives.

It is necessary for citizens and developers to understand that practice of appropriate land use considering disaster risks is right thing to do. It should show that taking safety measure is not foolish to do (Burby 1998). Developers should understand that avoiding the use of the land and choosing to use another land do not mean that they are paying costs and losing benefits.

The essential point whether the land is used properly or not depends on decisions and behaviors of citizens and developers. Behaviors, that is, practice of land use considering disaster risks, are related to how citizens and developers perceive disaster risks. It is essential that they become aware of disaster risks and understand risks appropriately. Also, it is important to know that each specific site has indigenous disaster risks.

Interpretation of information is related to interests of people. Moreover, how to use information is related to values and concepts of people. Decisions made on risk-aversive behaviors deeply depend on the benefits or cost it brings (Miletti 1999). Thus, how to interpret and use hazard information and make decisions on land use and the location of developments depend on peoples values about cost and benefit.

2.3.2 Risk Communication for Land Use Management

In order to raise risk awareness of citizens and developers to practice safety land use, hazard information of lands needs to be disseminated to reach them effectively. As hazard information is not the desirable information people are willing to share, it is necessary to develop the framework to deliver it automatically in social and economic system. New Zealand, France, England, or the United States has this kind of mechanism which is linked to social and economic system. For example, a review of hazard information is incorporated to insurance system, real estate trade, or application process for developments.

Central and local governments have responsibilities to promote risk communication between citizens and governments for the successful land use management. The method for risk communication should differ by countries or regions due to the differences of culture, level of education, or technologies they have.

2.4 Conclusions

Land use management is not easily understandable as a tool, such as seawall- or earthquake-resistant buildings for disaster risk reduction. Nonetheless, it is effective from the long-term perspective and sustainable measure. It is not a single measure but combination of various measures to reduce disaster risks through land use management. There is no single solution, but there are many different approaches which are applicable according to characteristics of countries or regions.

Managing land use properly leads to reduced disaster risks through development control. Understanding and acceptance of citizens toward policies and countermeasures are essential in implementing land use management policies. In order to facilitate understanding and acceptance, citizens first need to be aware of disaster risks. Risk communication between public and private sectors plays an important role for the risk awareness. Risk communication between public sectors and citizens is important to implement land use management. The first step is to disseminate hazard information with land use map by providing paper map or opening data on website.

Measures of land use management and risk communication are not the same and different by countries and regions. There is no single excellent practice, but they reflect their own backgrounds.

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Part II
Urban Issues in Land Use

Chapter 3
Experiences of Japan in Post-Hanshin-Awaji Earthquake

Michiko Banba

Abstract It has been 20 years since the occurrence of Hanshin-Awaji Earthquake in 1995, and infrastructure and buildings have rebuilt with revitalization of the city although Kobe, Hyogo, has recovered completely. In spite that there were damages to agricultural and fishery villages, most of the damages occurred in the city areas; thus, Hanshin-Awaji Earthquake is said to be an urban disaster. The recovery of Hanshin-Awaji Earthquake was called creative recovery, which means not only to recover the city as it was but to rebuild Kobe as the leading city of the twenty-first century. The recovery of the town has been achieved by city planning measure, such as land readjustment projects, urban redevelopment projects, and district plan. The damaged areas of Kobe have been reformed to be resilient against disasters by widening streets and roads and laying out open space or parks.

Keywords Earthquake • Land readjustment projects • Redevelopment

3.1 Introduction

Hyogoken-Nanbu Earthquake or Hanshin-Awaji Earthquake, which occurred in January 17, 1995 brought Kobe City and Hyogo Prefecture tremendous human and physical damages. More than 5000 people were dead, and more than 100,000 housings were damaged due to the shaking and fire following after the earthquake. Vulnerability, the low quality of earthquake resistance of housings and commercial buildings, or densely built-up residential areas with wooden small houses enhanced the extension of damages. Although strengthening of the earthquake resistance of building structure is promoted at the individual level, the fire resistance to suppress the spread of fire should be promoted both at individual building and collectively in the area.

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The recovery from the tragic disaster is professed to be a “creative reconstruction” to build back the damaged cities and to be more resilient, comfortable, vibrant, and global than before the earthquake (Hyogo Prefecture 1997). Recovery projects have been implemented to rebuild housings, important buildings, and commercial buildings; to recover livelihood of victims; and to change the land use of the damaged areas to be disaster resilient. In this chapter, roles of recovery projects to change the land use of damaged areas are discussed through the analysis of functions of factors which are related to the resilience of the town and city to earthquakes.

3.2 Factors Related to Vulnerability

Shaking and fire following after the earthquake brought human and building damages. Those damages were caused by fragile building structure and materials against shaking and fire. Collapsed buildings and structures crushed people to deaths and obstructed people to evacuate and emergency vehicles to rescue injuries and distinguish fire.

From the land use point of view, it is recognized that huge damages of Hanshin-Awaji Earthquake, especially damages caused by fire, were brought by narrow streets and roads and the lack of open space (Special Committee of Earthquake Disaster Recovery Planning of The City Planning Institute of Japan Kansai Branch 1995). Densely populated residential area with wooden small houses had been the top issue in earthquake disaster risk reduction in Japan, and those areas that are seen not only in the big cities but also located in 36 prefectures with the area of 7971 ha in total (Ministry of Land, Infrastructure, Transport and Tourism 2015). Features of the area are narrow streets and roads, limited open space, high density, and small wooden houses.

Two factors, open space and width of roads and streets, are explained from the view of vulnerability to enhance disaster and functions to promote resiliency.

3.2.1 Width of Roads and Streets

The area with narrow streets and roads has higher earthquake disaster risks. The fire can be spread if streets and roads are narrow, and it happened in Great Hanshin-Awaji Earthquake and also in Great Kanto earthquake of 1923. Conversely, wide roads and streets can enhance resiliency of the area.

The effects of the width of the road were more proved in Great Hanshin-Awaji Earthquake. Roads more than 12-m wide were found to obstruct the spread of the fire, while the damage of the area surrounded by narrower roads was heavier

((National Institute for Land and Infrastructure Management 2015). It was also found that roads more than 8-m wide were not blocked off, while many roads less than 4-m wide in heavily damaged areas were blocked off so that emergency vehicles such as fire engines or ambulances could not pass through those roads and emergency operations were disrupted in Hanshin-Awaji Earthquake (The Ministry of Construction 1982). Thus, widening of roads and streets is effective to restrain the spread of the fire and to make the area resilient.

3.2.2 Open Space

Open space was useful in the rescue operation and recovery phase after the earthquake occurred. Open space including the wide roads was also effective to restrain the spread of fire. Thus, it contributes to make the resiliency higher and to lay out the open space in the area.

Open space exits in the urban space as park, gardens, or street space, and it provided the people comfort or amenity in the ordinary time. In the emergency phase, open space can be utilized as evacuation site, supply base for relief supplies, or station for rescue teams (The Ministry of Construction 1982).

3.3 Recovery Projects Planning

3.3.1 Planning Framework

While recovering from the disaster to rebuild housing, industrial facilities, and administrative functions, recovery projects change the land use or the urban structure of the area to improve the area and become more resilient. Especially, densely populated area with small wooden houses was the target. One of the important purposes of recovery projects was to broaden streets and roads and lay out open space in such area to improve the vulnerability.

In order to promote recovery projects, “Act on Special Measures concerning Reconstruction of Urban Districts Damaged by Disaster,” the planning law, was legislated as one of the emergency legislations 1 month after the earthquake. The law enabled affected local government to designate areas where disordered developments might be placed if they are not well planned after the earthquake, as promotion. Any construction is prohibited in those areas for 2 years by the law, and reconstruction projects, such as land readjustment projects, redevelopment projects, or for the recovery, were planned to be implemented by local governments. Seven districts (five for land readjustment projects and two for urban redevelopment) were designated.

In implementing recovery projects, Kobe City adopted a two-stage planning process. The first stage is to develop the project framework and the planning of zoning by Kobe City. The second stage is concerned on decision-making planning for core city facilities (city streets and neighboring parks). Regarding urban redevelopment projects, some of the plans were revised in the process of implementation based on suggestions and proposals by Community Development Council.

3.3.2 Two-Stage Planning Process for Recovery Projects

Developments in the disaster-stricken area were forbidden by law for 2 months after the earthquake. It was required to develop a reconstruction plan to be approved during 2 months, which became a constraint to complete the procedure if the city tried to obtain the consensus of residents. In order to proceed the planning process in the limited time, a two-stage city planning process was adopted to implement the reconstruction projects. In the first stage, Kobe City designated a 5-ha area to be reconstructed and determined the method of implementing projects and important urban facilities to make vulnerable areas earthquake resistant. The plan was passed on March 16. It is a framework for the detailed plan developed in the second stage. Table 3.1 shows the details of those projects, which involve land readjustment and redevelopment. Figure 3.1 shows the locations of those project areas.

Afterward, the Community Development Council was established with the participation of residents in the heavily disaster-stricken area with the assistance of consultants. The Council developed the vision for recovery of the city and proposed to the city of Kobe. Then, Kobe City developed a detailed plan based on the vision, with the locations of roads, parks, and urban facilities based on the proposal (the vision) prepared by the Council. It was the second stage of the planning process. Detail of each stage is explained in the following sections.

3.3.3 Methods

3.3.3.1 Land Readjustment Projects

The land readjustment project was designed to improve the living environment and effective use of the land in urban areas by constructing necessary infrastructure and public facilities such as roads and parks. It required individual landowners to provide some portion of their lands for constructing roads and parks as the value of the land will be increased by the land readjustment project (Fig. 3.2).

Table 3.1 City planning projects for recovery

	Districts for land readjustment projects					Districts for land redevelopment projects	
Names	Moriminami	Rokkomichi Station West	Matsumoto	Misuga	Shin-Nagata, Takatori	Rokkomichi South	Shin-Nagata Station South
Area(ha)	16.7	19.7	8.9	10.1	69.2	5.9	0
Damage ratio	66	68	81	88	86	65	83

Source: Kobe City (2011)

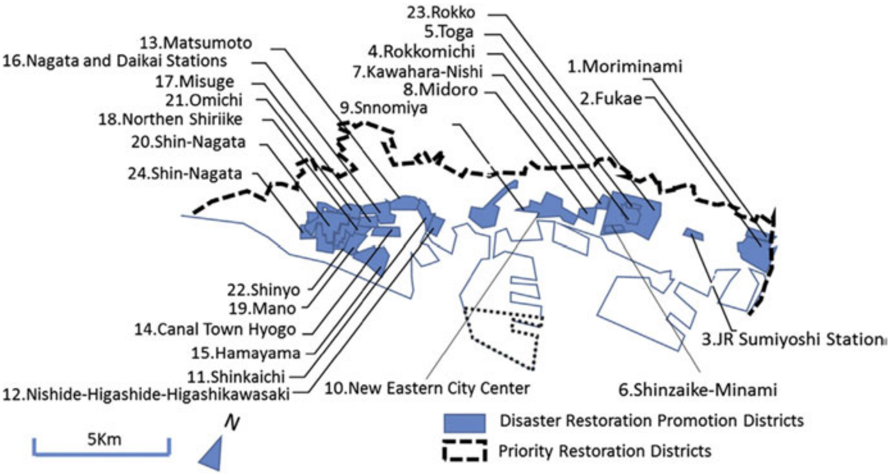

Fig. 3.1 Designation of disaster restoration promotion districts and priority restoration districts (Source: Kobe City (2011))

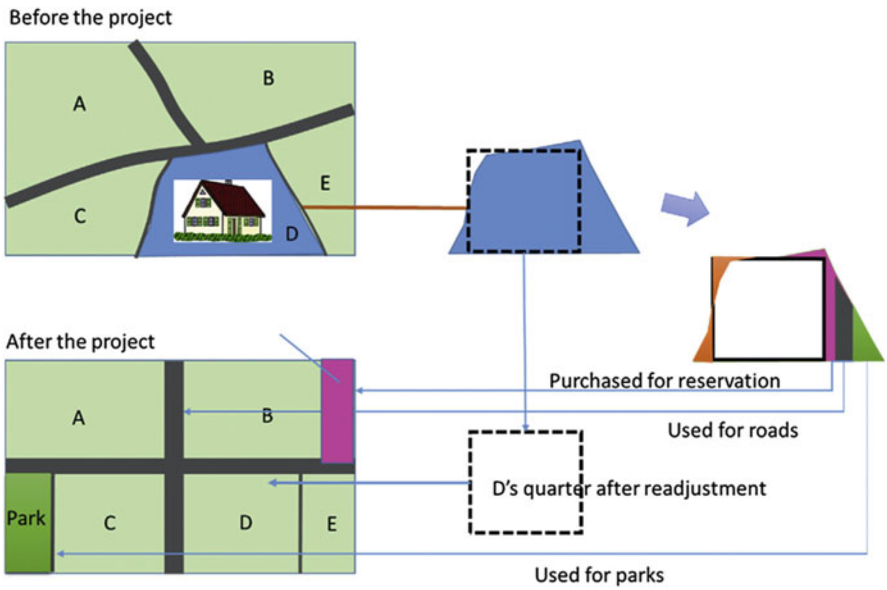

Fig. 3.2 Land readjustment projects

3.3.3.2 Redevelopment Projects

The purpose of redevelopment projects is to make good use of urban space effectively and renovate urban functions through the redevelopment of the densely developed area with old wooden buildings. Subdivided lands are to be merged, buildings with incombustible materials are to be constructed, and pars open space and wide

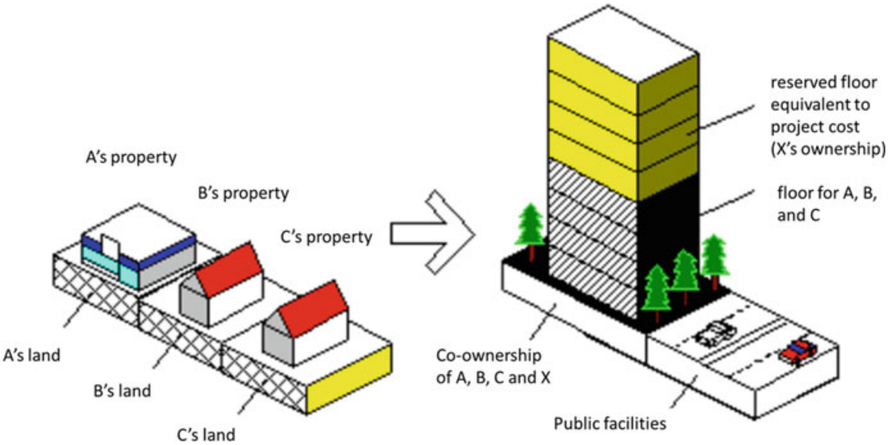

Fig. 3.3 Image of redevelopment project scheme (Source: Ministry of Land, Infrastructure, Transport and Tourism 2015)

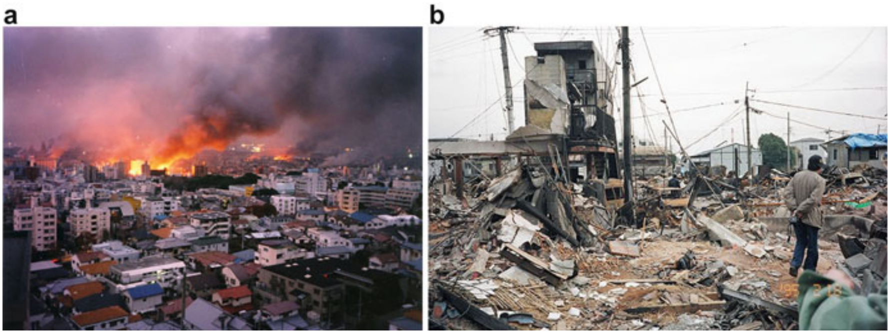

Fig. 3.4 Photos of Rokkomichi North area after the earthquake (Provided by Mr. Ikuo Kobayashi)

streets are laid out. As most of the damaged area was densely developed area with old wooden buildings, redevelopment project was one of the effective tools for the recovery of the town. However, redevelopment is the expensive method, and it can be a burden to the local government. Thus, redevelopment projects were implemented only in two sites. Image of the redevelopment project is shown as Fig. 3.3.

3.4 Cases: The Rokkomichi Area

The area around JR Rokkomichi Station was one of the seriously damaged areas by the earthquake. Especially, Rokkomichi North area was a densely populated area with small wooden small houses, and the fire occurred after the earthquake burnt the area as shown in Fig. 3.4a. Figure 3.4b shows the photo after the fire was distinguished. Recovery projects implemented in Rokkomichi area to recover and renovate the damaged area and surrounding area are explained afterward.

Fig. 3.5 (**a**) Rokkomichi North project plan, (**b**) the undamaged area near Rokkomichi North district before the earthquake, (**c**) the reconstructed area in Rokkomichi North district after the earthquake (Source: Kobe City, "Rokkomichi North Land Readjustment Project, http://www.city.kobe.lg.jp/information/project/urban/adjustment/jl00044.html (2010.9.1))

3.4.1 The Rokkomichi North District

The Rokkomichi North area (16.1 ha) is located in the eastern part of Kobe. Before the earthquake, the area included both residential and neighborhood commercial establishments. The earthquake damaged two-thirds of the area by the heavy shaking and fire following the earthquake. The area was reconstructed by implementing land readjustment project (Fig. 3.5).

Streets were widened as shown in photo (c) of Fig. 3.5 comparing with photo (b). It is effective to block the spread of fire to reduce damages. Also, several parks from large to small were laid out in the area. Those parks which are equipped with the emergency tools were planned to be used as shelters in the emergency phase.

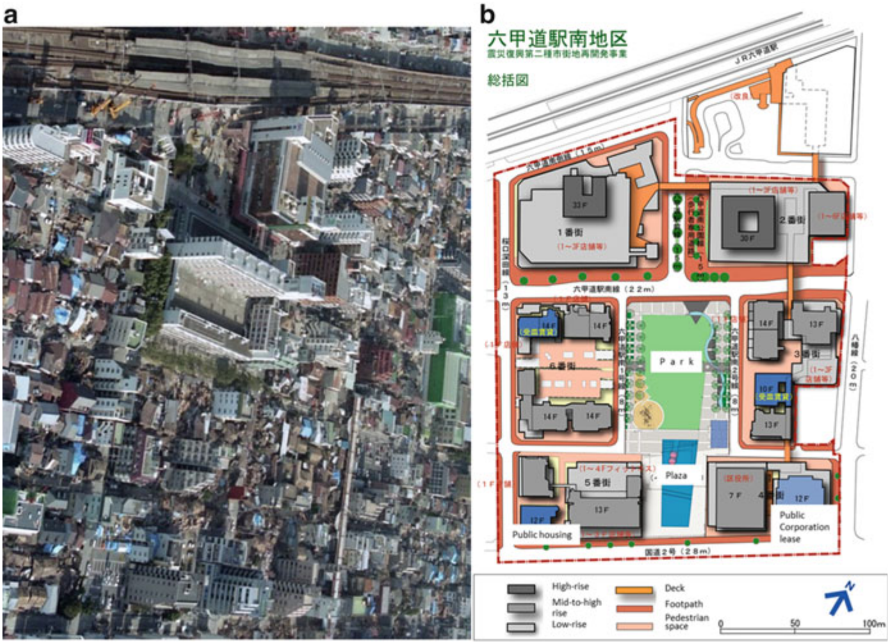

Fig. 3.6 Rokkomichi South area. (**a**) Rokkomichi South immediately after the earthquake. (**b**) Rokkomichi South recovery project plan (Source: (**a**) Kobe City (2015) (**b**) Kobe Housing & Urban Development Corporation 2016)

3.4.2 The Rokkomichi South District

Rokkomichi South area is located in front of JR Rokkomichi Station and defined as the eastern subcenter of the city in the "Kobe City Basic Plan" (Fig. 3.6). This area was not utilized enough as a subcenter although there were some buildings which were planned for mix use of commercial and residential purposes adjacent to the JR Rokkomichi Station. In order to recover the Rokkomichi South area, the redevelopment project was implemented.

The purpose of the redevelopment project was to recover the area damaged seriously by the earthquake and to renovate the area into resilient and comfort urban area. It provides housing (915 housing units) for victims who lost their houses and urban facilities. Public opinions were reflected in the plan through public participation in the planning process. The project was completed in 2005, 10 years after the earthquake.

3.5 Conclusions

The characteristic of the recovery from Hanshin-Awaji Earthquake can be explained through the use of big urban redevelopment and regeneration projects. Those projects were effective to recover the damaged area, strengthen the resiliency, and renovate urban comforts. The recovery from Great East Japan Earthquake in 2011 is also the same type of the recovery methods as well. However, large amount of finance was needed to complete the projects. Thus, this kind of recovering approach is suitable for countries that have an affluent budget.

Another large-scale earthquake is expected to occur in Japan in the near future. Nonetheless, we do not know those methods will be suitable to recover from the disaster. Japan is in the phase of population decrease and not in the economic growth age. It is definite that Japan is getting into the age of social and economic change. It might be the time to shift from expensive recovery to reasonable recovery and start thinking of a new approach.

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Chapter 4
The Reconstruction of Bhuj: Reflecting on the Planning Process

Balakrishnan R. Balachandran

Abstract The Gujarat earthquake in 2001 was one of the first major natural disasters in India significantly impacting urban areas. Considering this fact, in retrospect it appears that the degree of success achieved in rebuilding the affected towns is quite remarkable. Post-disaster reconstruction situations are often characterized by expedient decision-making leading to the creation of new vulnerabilities instead of taking the opportunity to build resilience. This case study discusses two redeeming aspects of the planned reconstruction carried out in the town of Bhuj, very close to the epicenter of the quake and one of the most affected areas: (1) the role of land use planning and development control regulations at the city level in creating a new regime of resilience in this highly hazard prone city and (2) the role of land pooling in achieving relatively resilient reconstruction in the old city of Bhuj, a very densely built historic fabric. The author, who led the team that prepared the plans at both the city level and in the old city, takes advantage of the intervening years to reflect on the process, on the achievement, as well as on lost opportunities.

Keywords Urban reconstruction • Post-earthquake reconstruction • Urban planning • Land readjustment

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The author is an architect and urban planner. During the reconstruction of Bhuj, Mr. B.R. Balachandran held leadership positions in the team of urban planners from Environmental Planning Collaborative (EPC), Ahmedabad, who prepared the plans for reconstruction. In the initial phase – preparation of the Development Plan – the author was a joint Team Leader (along with Ms. Shirley Ballaney) and in the latter phase – preparation of Town Planning Schemes – he was the sole Team Leader. Throughout the process, Dr. Bimal Patel, who founded EPC, guided him. The author currently heads Alchemy Urban Systems Pvt. Ltd. an urban planning consultancy that he cofounded with Mrs. Sowmya Balachandran.

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4.1 Introduction

Nearly a decade and half after the devastating earthquake that hit Bhuj,[1] it is possible to look at most parts of the city and wonder whether indeed there was an earthquake here. Such is the level of reconstruction that has been accomplished. The city has grown, not just in terms of population and spatial extent but also in terms of its economy and infrastructure. Not many cities around the world, impacted by similar disasters, can claim this sort of success. Therefore it is a privilege to be writing this paper, as a person who was closely involved in the planning process that accompanied the reconstruction. The reconstruction of Bhuj was a huge team effort that brought together thousands of people from different walks of life—construction workers, contractors, engineers, planners, administrators, social workers, and political leaders. As the leader of a small team that played a crucial role in this massive exercise, there is an inevitable bias in the authoring of this paper.

This paper reflects on the process of planned reconstruction that unfolded in Bhuj and seeks to highlight the role of government in establishing a system-driven approach. The purpose here is to set such an approach apart from relatively ad hoc processes that are in evidence in most post-disaster situations. The rebuilding of Bhuj also demonstrates a balanced approach—one that consistently sought the middle path between contrasting and often competing options like relocation versus in situ reconstruction. The classical post-disaster trade-off—between speed and quality of processes and products—was very much at play in Bhuj too, but the manner in which this trade-off was negotiated is something to learn from. There were mistakes too, and many a missed opportunity. It is useful to sit back now and reflect on these.

This paper draws heavily on previously published papers including the author's contribution to the recently published *Handbook on Reconstructing after Disasters* by the World Bank as well as a similar retrospective published by the Government of Gujarat on the tenth anniversary of the earthquake. The only additions/changes are refined insights based on more experience. Therefore, the author offers apologies to those who are already familiar with his spiel on Bhuj reconstruction.

4.2 Creating the Road Map for Reconstruction: The First 4 Months

In retrospect, one of the best elements of the approach to reconstruction is the openness with which the Government of Gujarat accepted help from across the country and the world. In the immediate aftermath of the earthquake, the author was part of

[1] Bhuj, a town of about 250,000 currently (150,000 at the time of the quake), is the headquarters of the district of Kutch (in the state of Gujarat, India), the theater of the maximum destruction in the quake. The epicenter was near Bhuj, by virtue of which, the earthquake is often referred to as the Bhuj earthquake.

an exploratory effort from EPC[2] to understand how professional planning can contribute to post-disaster reconstruction (Balachandran 2006). During this period, the author could meet with a galaxy of people experienced in reconstruction in the field offices set up by the district administration and the Kutch Navnirman Abhiyan, a collective of NGOs in Kutch. Within weeks, a clear consensus seemed to emerge regarding the approach to rural reconstruction. The past experiences of Latur and Uttarkashi earthquakes had helped a lot in this regard. The government announced its rural reconstruction policy in a very short time. However, the policy for urban reconstruction took a little longer.

4.2.1 Relocation vs. In Situ Reconstruction

It is now a well-known fact that public opinion varies steadily over a period of time following a disaster. While initial reactions are motivated primarily by fear, gradually other practical considerations take over as fear subsides. In the immediate aftermath of the earthquake, the discussion both among citizens and in the government revolved around two drastic alternatives—total relocation of the city ("New Bhuj") and in situ reconstruction (Balachandran and Patel 2006). One of the proposals was to turn the old city into an earthquake museum and build a new township for all inhabitants and businesses. There were public protests in Bhuj led by business groups and professionals demanding that the old city should be rebuilt. At the same time, studies by EPC as well as the urban design faculty of the Centre for Environmental Planning and Technology (CEPT)[3] concluded that it was important to rebuild the old city of Bhuj, as it was important for the culture, history, and economy of this historic town.

It was also pointed out that across the world one could find examples of entire cities being rebuilt from rubble. However, rarely if ever would one find a successful example of a city, particularly one with historic significance, being willfully abandoned and a new one built elsewhere, forcibly relocating an entire population and its activities (even in disaster-prone areas). A few references in this regard would be useful to set the context. A document prepared by a global expert team to guide

[2] The Environmental Planning Collaborative (EPC) is a not-for-profit organization based in Ahmedabad, which developed progressive approaches to urban and regional planning during a period starting 1997. Before the earthquake in January 2001, EPC had already carried out a regional planning exercise in Kutch. The EPC team undertook three initiatives other than its consultancy assignment for preparing development plans. These included (i) mapping of the four affected towns in Kutch, funded by US-Asia Environmental Partnership (these maps were used for planning in all four towns); (ii) Initiative for Planned and Participatory Reconstruction funded by the USAID FIRE Project (which contributed to strategic planning for Bhuj); and (iii) a book on the art, architecture, and history of Bhuj authored by Azhar Tyabji.

[3] CEPT is now CEPT University.

Haiti's reconstruction gave the following historical examples for rebuilding vs. relocation (Global Facility for Disaster Reduction and Recovery (GFDRR) 2010):

- 1755—Lisbon (Portugal) destroyed and rebuilt in the same location with special seismic design.
- 1773—Antigua (Guatemala) destroyed for the second time and moved to Guatemala City (heavily damaged in 1976 with 23,000 killed).
- 1841—Cartago (Costa Rica) destroyed by earthquake and moved to San Jose.
- 1854—San Salvador (El Salvador) heavily damaged, also in 1917, 1986, and 2001 but remains the capital in the same location.
- 1906—San Francisco (USA) totally destroyed by earthquake and fire. Despite pre-earthquake new City Beautiful urban plan by Daniel Burnham, the city was rebuilt exactly the same, due to difficulties in changing existing property rights.
- 1907—Kingston (Jamaica) heavily damaged and rebuilt in the same location with height limits imposed on buildings.
- 1923—Tokyo (Japan) largely destroyed by earthquake and fire and rebuilt as before.
- 1967—Caracas (Venezuela) heavily damaged and rebuilt in the same location.
- 1972—Managua (Nicaragua) largely destroyed by earthquake and the city center remains largely abandoned today.
- 2004—Aceh (Indonesia) 60 % destroyed by tsunami and largely rebuilt in the same place.
- 2005—Hurricane Katrina devastated New Orleans (USA), as of 2009, population only 60 % of pre-Katrina.

The World Bank's manual on post-disaster reconstruction mentions that relocation is sometimes perceived to be the best option after a disaster for one or more of the following reasons: (1) people have already been displaced by the disaster, (2) their current location is judged to be uninhabitable, or (3) relocation is considered the best option to reduce vulnerability to the risk of future disasters. In fact, relocation may be appropriate when the disaster is the result of site-specific vulnerabilities (Jha et al. 2010). In the case of Bhuj, however, the entire region was highly vulnerable, and it seemed futile to make a distinction for the Walled City area without compelling evidence to support such a decision.

Having carefully considered all options, in April 2001, the government formulated a reconstruction package for the affected urban areas of Gujarat, with separate sections for Bhuj, Bhachau, Anjar, and Rapar.

4.2.2 The Urban Reconstruction Package

The urban reconstruction package announced in April 2001 walked the middle path—it favored partial reconstruction and partial relocation. It envisaged the following:

- Reduction of development intensity in the urban areas by restricting both height of the building and the permissible FSI,[4] implying horizontal expansion of the city, both during reconstruction and in the years to come.
- To guide and regulate the reconstruction and growth of the city, the government package announced that town planning would be carried out and that the development control regulations would be revised.
- The package offered plots at relocation sites both to homes and businesses that wished to relocate from the Walled City and to those that would be affected by town planning proposals. Though the sites were not specified, possible locations were indicated based on the availability of vacant government land.
- In the case of Bhuj, the package also specifically mentioned that government properties inside the Walled City would be made available for the redevelopment of the Walled City. There were special provisions for tenants and unauthorized/illegal settlements.

The package was not without issues. The provisions for tenants were not clearly spelt out. If they had been, the resistance to town planning proposals in the old city would have been less later on. Unlike the rural reconstruction package, there were no provisions for partnership with NGOs. Though this was introduced later on, it was not structured as well as in the case of rural reconstruction. The policy for valuation of plots offered at the relocation sites and plots to be surrendered in the Walled City were also somewhat confusing.

4.2.3 Institutional Framework

One of the biggest governance challenges in post-disaster reconstruction is the allocation of responsibility between central/provincial and local governments. Here again, the Government of Gujarat took the middle path. It was quite clear that the task that lay ahead was monumental and none of the local government agencies had the technical or financial resources to manage the reconstruction. The Government of Gujarat, through its Urban Development Department, created the following institutional framework (Fig. 4.1) for undertaking reconstruction (Balachandran 2009):

- In May 2001, the government created the Area Development Authorities (ADAs) in Bhuj, Bhachau, Anjar, and Rapar under the provisions of the Gujarat Town Planning and Urban Development Act, 1976. The ADAs were made responsible for implementing town planning proposals and ensuring adherence to improved regulations.
- The government negotiated a loan of five billion Indian rupees (about 100 million USD in that period) from the Asian Development Bank to fund urban reconstruction.

[4] "Floor space index" – the ratio between total built up area on a plot to the area of the plot and also referred to as floor area ratio (FAR).

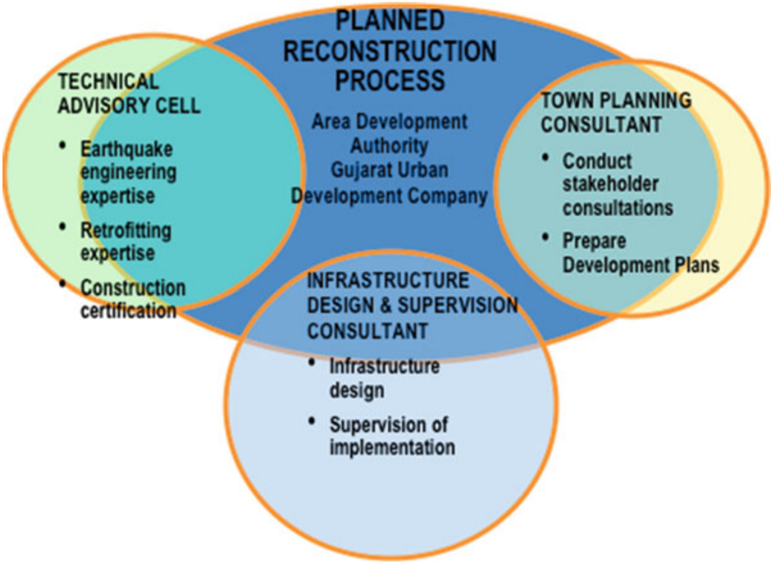

Fig. 4.1 Institutional framework

- Since the post-earthquake urban reconstruction project demanded special attention, dedicated staff, and special skills, the government decided to designate the Gujarat Urban Development Company Limited (GUDC) as the implementing agency for the project. The GUDC is a special purpose vehicle established by the government (before the earthquake) for conceptualizing and implementing urban development projects.
- To support the ADAs and GUDC, the government decided to hire consultants for town planning and infrastructure planning and to scrutinize applications for building permissions.

While constituting the Board of the Bhuj Area Development Authority (BHADA), the government included two technical experts, but the system was never geared to utilize their expertise and experience. It seems like an omission that there was no local representation in the Board. Perhaps the intention was to avoid unnecessary interference, but in retrospect, such fears seem misplaced. Local representation would have helped both in improving the plan and in legitimizing it. In addition, the Bhuj municipality had very little direct role to play in the reconstruction. Being an elected body, the municipality has a larger stake in the overall development of the city. While the Area Development Authority played a major role in preparing the development plan and Town Planning Schemes and issuing building permissions, now the capital assets (infrastructure) and their operation and management need to be taken over by the municipality. However, the municipality's capacity has not been built up systematically, and even today, this institution is not really geared to take on the management of the rebuilt, expanded, and fast-growing city that Bhuj has become. Another issue with the institutional framework was the role of the

Technical Advisory Cell. The agency hired to provide engineering expertise and to scrutinize building permissions eventually got removed partly because they got deployed ahead of time and were redundant, but mainly based on the perception that an external agency should not be involved in this task.

4.2.4 *Legal Framework and Tools for Planning and Implementation*

From an urban planner's point of view, one of the most creditable aspects of the Government of Gujarat's approach to urban reconstruction is the recognition that the extent of destruction that happened in the earthquake is the result of a systemic failure of planning and regulation and therefore its focus on dealing with these systemic issues in the process of reconstruction itself. The government decided to utilize statutory town planning mechanisms such as development plans since ad hoc project formulation will not suffice for ensuring mitigation of future disasters. The government reviewed the conventional procedures adopted for the preparation of development plans and identified ways in which to shorten the duration of the process. The development plan preparation (Fig. 4.2) is a three-stage process:

1. Preparation and publication of the Draft Development Plan under Section 13 of the Town Planning Act for objections and suggestions from the public
2. Review of objections and suggestions, revision of the plan, and publication under Section 15 for a second round of objections and suggestions
3. Review of objections and suggestions, revision of the plan, and submission to the state government for sanction.

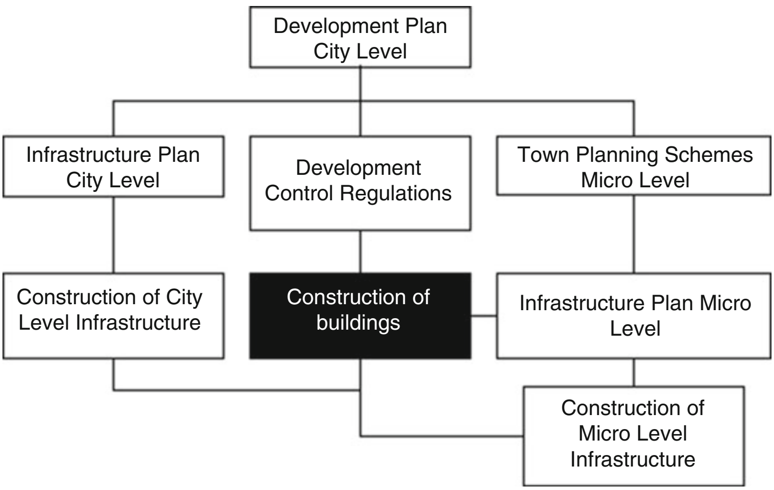

Fig. 4.2 Overall process flow chart

To cut short the time required for the above process, in mid-May 2001, the Town Planning Department prepared a Draft Development Plan on the basis of readily available data and maps and published the same under Section 13 for objections and suggestions. Meanwhile the government appointed consultants through an open competitive bid to undertake a more detailed and systematic exercise. While time was certainly saved, this procedure did create confusion on two counts: (i) the proposals for road widening in the plan were objectionable to many affected citizens and (ii) there was a disconnect between a published plan and simultaneous public consultations by the newly appointed town planning consultants.

4.3 The City-Level Development Plan: The Next 7 Months

The preparation, publication, revision, and approval of a city-level development plan normally take 2 years at the very least for a city the size of Bhuj. However, in the case of Bhuj, Bhachau, Anjar, and Rapar, despite the complexities involved, the government achieved this stupendous task in just 6 months (Table 4.1) and that too with much greater detail, accuracy, and public participation than ever done before, at least in Gujarat if not in India (Balachandran 2009).

4.3.1 Mapping, Studies, and Public Consultations

The planning area delineated for Bhuj covered 56 km^2 to accommodate the growth of the city that housed a population of 125,000 at that time. The last development plan for Bhuj (Fig. 4.3) was made in 1976—25 years before the earthquake. The city had not been resurveyed for three decades. The base maps were hopelessly outdated and devoid of detail. There were no contour maps (EPC and GUDC 2001).

Table 4.1 Development plan timeline

May 18, 2001	Start of project
	Base map preparation
	Data collection
	Stakeholder consultations
July 15, 2001	Completion of Conceptual Development Plan
	Stakeholder consultations
	Detailed studies
	Final base map
September 15, 2001	Completion of Draft Development Plan
	Formal objections and suggestions from citizens
	Plan revision and finalization
	Submission to the state government
December 15, 2001	Sanction of Draft Development Plan

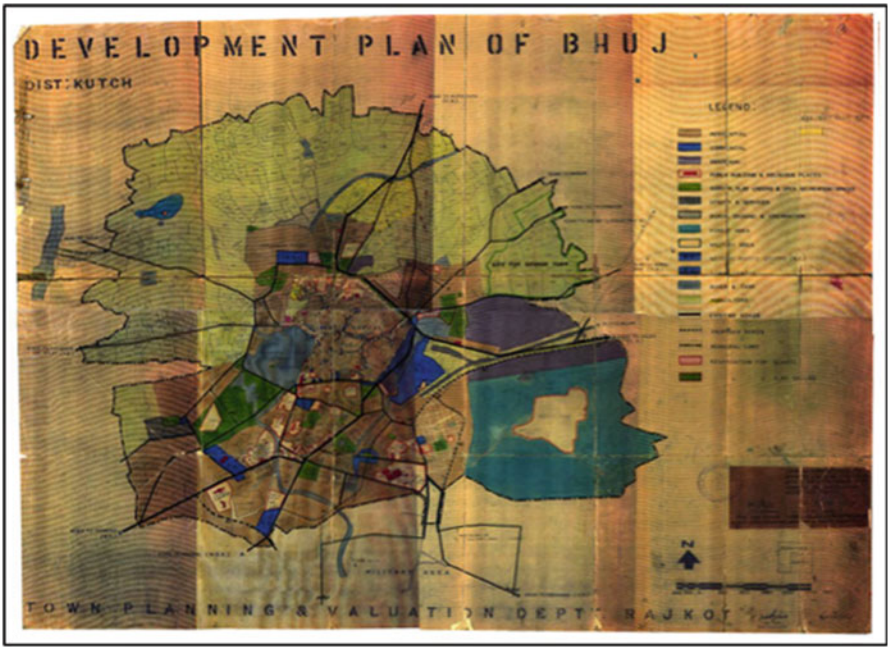

Fig. 4.3 Development plan 1976 (EPC and GUDC 2001)

The entire planning area was resurveyed in great detail with the latest computerized equipment in just 2 months. The reconciliation (Fig. 4.4) of the survey outputs with the 30-year-old official maps and land records of the City Survey Department and the District Inspector of Land Records—a very tedious and painstaking task—took an additional 4 months. This procedure of reconciliation is known in Gujarat as *melavni*, which literally means, "matching." While the status of base maps were not exceptional to Bhuj (this is the state of land records all over India), the problems caused by this in the post-disaster situation were particularly complex.

A series of studies (Fig. 4.5) was carried out in record time to assess earthquake risk in different parts of the city and surroundings as well as to provide inputs to the development plan. These studies included:

- Land suitability analysis
- Demographic studies
- Land market
- Infrastructure status and needs
- Intensity of damage
- Rehabilitation needs

The Gujarat Urban Development Company (GUDC) commissioned a study by the Geological Survey of India to assess soil conditions in various parts of the city from the point of view of suitability for foundations of various kinds of buildings.

Fig. 4.4 Base map preparation (EPC and GUDC 2001)

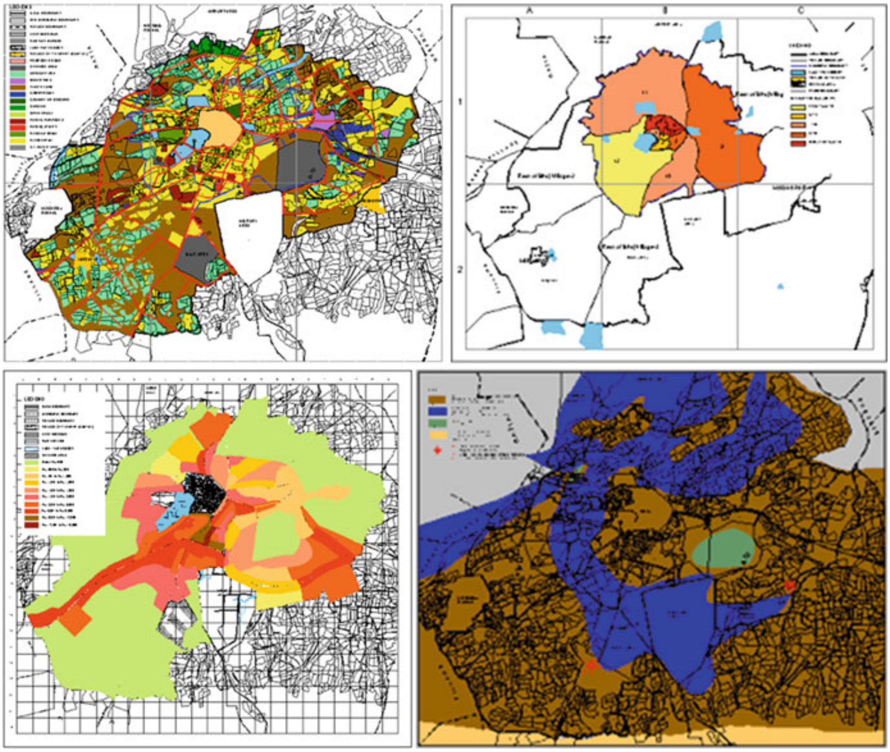

Fig. 4.5 Studies (EPC and GUDC 2001)

While the scientists broadly categorized the city in terms of good, fair, and poor soil conditions, their study could not give concrete micro-level information that could be incorporated in the regulations, nor did the study conclusively rule out development in any part of the city. "Micro-zonation" was not carried out for Bhuj in time for informing the development plan. The results of a micro-zonation study would probably have provided inputs for structural design of buildings in specific locations rather than land use zoning in the development plan.

A household-level questionnaire survey was carried out, interviewing 2500 families and several hundred trade and industrial establishments. A series of public consultation exercises (Fig. 4.6) was carried out in two rounds. The first round of meetings was with opinion leaders and specific stakeholder groups leading up to the preparation of a Conceptual Development Plan. In the second round of consultations, the Conceptual Development Plan was presented at a series of public meetings and group discussions including a city-level workshop with invitees from a cross section of Bhuj society. Those consulted including local and state government officials, community groups, representatives of trade and industry, real estate developers, opinion leaders, professional groups, women's groups, artisans' groups, and defense

Fig. 4.6 Stakeholder consultations (EPC and GUDC 2001)

officials. In all over 150 consultation meetings were held and documented (EPC and GUDC 2001).

At the city-level workshop, a vision statement for Bhuj (Box 4.1) was formulated. This vision informed the planning decisions in the development plan, Town Planning Schemes, and even later efforts by local stakeholders.

Box 4.1. Vision Statement for Bhuj (EPC and GUDC 2001)
Vision statement

The vision statement for Bhuj, developed through the public consultations and studies, attempted to visualize what citizens would like to see when they look at Bhuj a decade after the earthquake. They would like to see that:

- Bhuj is a **vibrant center for trade and commerce** in Kutch specializing in handicrafts and mining-based industries and building material manufacturing and trading.
- Bhuj is a major **tourist destination** and the main entry point for tourism in Kutch.
- All earthquake-affected citizens of Bhuj have been **rehabilitated** physically, economically, and socially.

(continued)

Box 4.1 (continued)

- Bhuj is equipped to withstand and **manage disasters** with minimum loss of life and property.
- The urban form of Bhuj, particularly the Walled City, reflects its traditional **cultural identity**.
- Bhuj has an **efficient water management system** that conserves precious water resources, reuses water, and recharges the aquifers.
- Buildings, public spaces, and public services and amenities in Bhuj are designed to cater to the needs of **vulnerable social groups**.

Having involved stakeholders in a consultative process ensured that many ideas contained in the development plan developed a life of their own. For example, the vision of managing water was later pursued by NGOs in Bhuj—Sahjeevan, Hunnarshala Foundation, and Kutch Navnirman Abhiyan—through their own programs.

4.3.2 A Comprehensive, Integrated Approach to Development

Before the initiation of the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) in 2005, the city-level planning in India consisted of statutory development plans or master plans (land use plans) at one extreme and ad hoc infrastructure project formulation at the other end. The statutory plans typically focused only on two aspects, the first being land use planning and development controls—the regulatory aspect. The second aspect is the demarcation of land for public infrastructure such as roads, public open spaces, and other public facilities like bus terminals, major facilities for health and education, government offices, etc. The development plan for Bhuj had both these aspects, and in addition, it also looked at strategic planning for the city's development, making it more advanced than most city-level planning exercises in the country at that time.

The overall approach of the development plan consisted of:

- Development of relocation sites for those who opted to move out of the Walled City
- Development of a skeletal framework of wide roads to accommodate the horizontal growth of the city
- Comprehensive redevelopment of the Walled City
- Initiatives to stimulate economic development

The specific sections of the development plan report were as follows (EPC and GUDC 2001):

1. Relocation and rehabilitation
2. Economic development
3. Land development
4. Road network and transportation
5. Physical infrastructure
6. Social infrastructure
7. Open spaces, water bodies, and environment
8. Heritage conservation and tourism
9. Solid waste management
10. Informal sector
11. Implementation strategy

The approach adopted for relocation and rehabilitation is dealt with later in this paper. In the section on economic development, there were several proposals—short term and long term—to help revive the economy. These included initiatives like setting up temporary markets to establishing a new freight complex, an industrial zone, and tourism promotion.

The road network and transportation section conceptualized the future urban structure of Bhuj with a pattern of ring and radial roads, building on the existing pattern. The proposed land use zoning is integrated with this road network in a synergistic manner. For example, the commercial corridors follow the arterials. The plan facilitates the redistribution of intensity of land use—both residential and commercial over a much larger area than pre-earthquake. Earlier, a quarter of the population of Bhuj lived in the Walled City—35,000 people in 1 km^2 and the remaining 90,000 spread over 20 km^2. Post-earthquake, the government took a decision that in the entire Kutch region, building heights should be restricted to two floors by default with only rare exceptions to be made. The intention was to strengthen building controls and enhance quality of design and construction before relaxing height limits. In any case, the height limit, along with the provisions for relocation and rehabilitation, ensured that during the reconstruction process, the city would spread outward. The proposed land use plan is designed to accommodate not only this immediate requirement but also the demand for land generated by the anticipated growth of the city in the post-disaster economic boom.

In retrospect the above approach to planning seems to have paid off. In the decade that followed the earthquake, numerous industries have come up in Kutch resulting in a substantial increase in population as well as in real estate development in Bhuj. The new road network (Fig. 4.7) and land use zoning (Fig. 4.8) can now be seen to organize this growth in a systematic manner.

The key features of the approach to land use zoning in the development plan were as follows (EPC and GUDC 2001):

1. All ecologically significant areas such as water bodies and their riparian borders were zoned as open spaces to be protected and used only for compatible uses.

Fig. 4.7 Proposed road network (EPC and GUDC 2001)

2. Adequate area was zoned for residential and nonresidential urban uses (such as commercial, institutional, and industrial) to ensure that there would be less pressure to carry out unauthorized or illegal development in no-development zones
3. The permissible density (of built up area) in residential and nonresidential urban zones was kept relatively low to reduce risk (considering the limitations of enforcement of building safety norms).
4. Higher intensity developments such as commercial and institutional were located along the major arterial roads to enable land use—transport integration.

The planning of physical infrastructure is dealt with separately later in the paper. Assessments of the social infrastructure revealed a concentration of health and educational infrastructure in the south and west of Bhuj, while the north and east where the poorer sections lived were deprived. Proposals dealt with enabling a balanced distribution of facilities, but have not really been taken up for implementation.

Bhuj is blessed with a bowl-shaped topography. Rainwater drains into the Hamirsar Lake in the middle of the city through a series of water bodies (Fig. 4.9) interconnected by water channels both natural and man-made. This water management system had deteriorated over time, lakes were filled up, and channels were blocked. The development plan proposed to revive this system. It was also

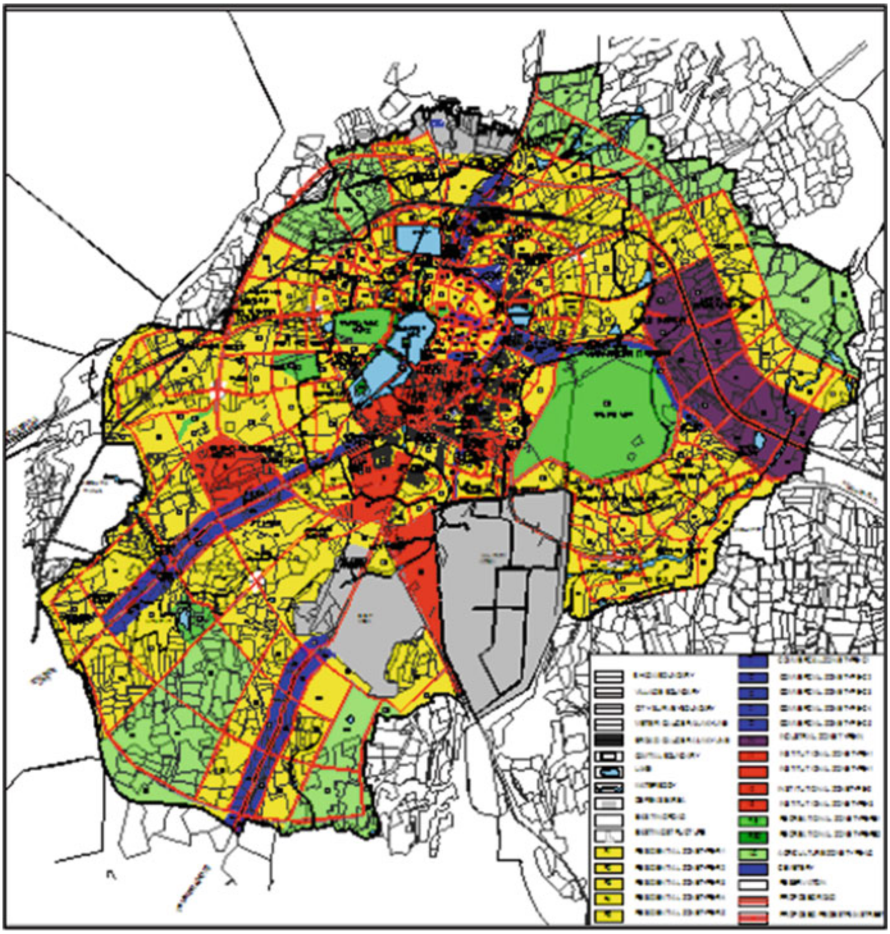

Fig. 4.8 Proposed land use plan (EPC and GUDC 2001)

proposed to develop the edges of all water bodies and water channels as publicly accessible green spaces. Though these proposals were not included in the reconstruction project, there was a public initiative led by the Hunnarshala Foundation and ACT (Arid Communities and Technologies), Bhuj-based NGOs. This is one of the first efforts in the country to undertake comprehensive urban watershed management.

The development plan proposals for heritage conservation dealt with both the need for restoring specific heritage assets as well as realizing the economic potential of cultural tourism. During the reconstruction process, much was achieved in terms of restoration of specific heritage structures through the efforts of district administration of Kutch (described later in the chapter). However, a concerted effort to establish conservation practices is still pending. Through a separate initiative, Azhar Tyabji, an art historian at EPC, authored a book on the cultural history of Bhuj,

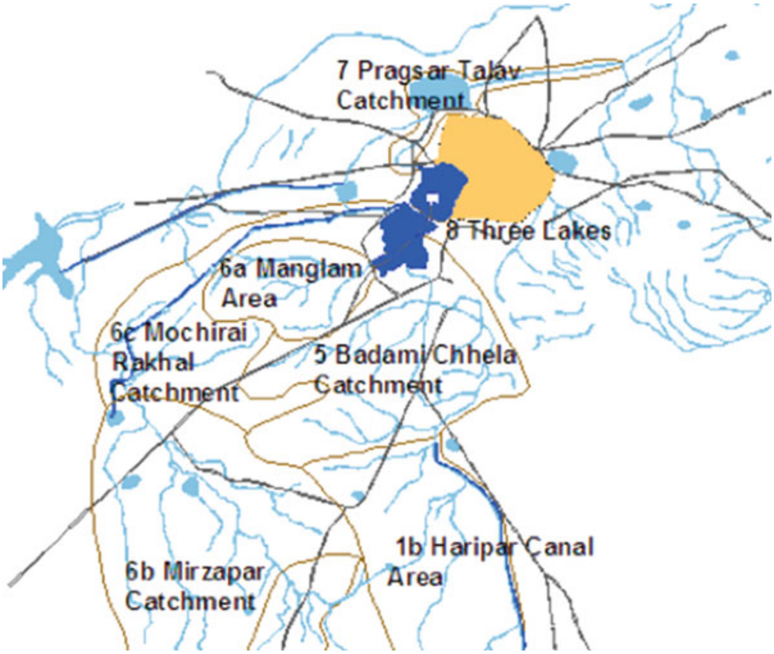

Fig. 4.9 Water bodies

published by MAPIN publishers. Another independent initiative was led by Debashish Nayak of CRUTA Foundation to establish a Heritage Society and to launch a Heritage Walk (Fig. 4.10) similar to the one he created in Ahmedabad.

Proposals for solid waste management, dealt with conceptually in the development plan, were detailed and implemented later. The chapter on "Informal Sector" that dealt with both informal settlements (slums) and informal sector economic activity is probably the most neglected part of the plan. However, recently there have been many initiatives for providing access to water supply and sewerage to slums. The biggest hurdle in all such initiatives is the issue of granting tenure. Much better work on this issue has been carried out in Bhachau[5] as compared to Bhuj. A land use survey conducted by Alchemy Urban Systems Pvt. Ltd. in collaboration with Hunnarshala Foundation and ACT in 2008 revealed that the slum population in Bhuj has increased substantially in the intervening period.

The implementation strategy section provided a broad estimate of the cost of implementation and proposed land management mechanisms to recover at least a part of the cost. However, the entire focus of the reconstruction process was on speedy implementation of public infrastructure and therefore cost recovery took a back seat.

[5] The work on tenure issues in Bhachau was spearheaded by an NGO named Unnati Foundation for Development.

Fig. 4.10 Heritage Walk brochure

4.3.3 Approval of the Development Plan

Based on responses received during the presentation of the Conceptual Development Plan in July–August 2001, modifications were made, proposals were detailed, and the Draft Development Plan was published in September 2001 (under Section 15 of the Act). The plan was open for objections and suggestions from the public for 2 months, that is, till mid-November 2001. After incorporating changes based on public responses and corrections in the base map, the plan was finalized in December 2001 and sanctioned immediately by the state government.

4.3.4 Planning of Relocation Sites

The Draft Development Plan published in September 2001 proposed seven possible relocation sites (Fig. 4.11) based on availability of government land (EPC and GUDC 2001). This ensured that no cumbersome land acquisition process had to be undertaken. By September 2001, the relocation sites were designated, by October they were transferred to BHADA and demarcated on the ground, and in November 2001, the work on the layout was initiated. In December 2001, the preliminary layouts were ready. Based on the announced government policy, a procedure was formulated to determine what relocation applicants were entitled to receive their “entitlement.”

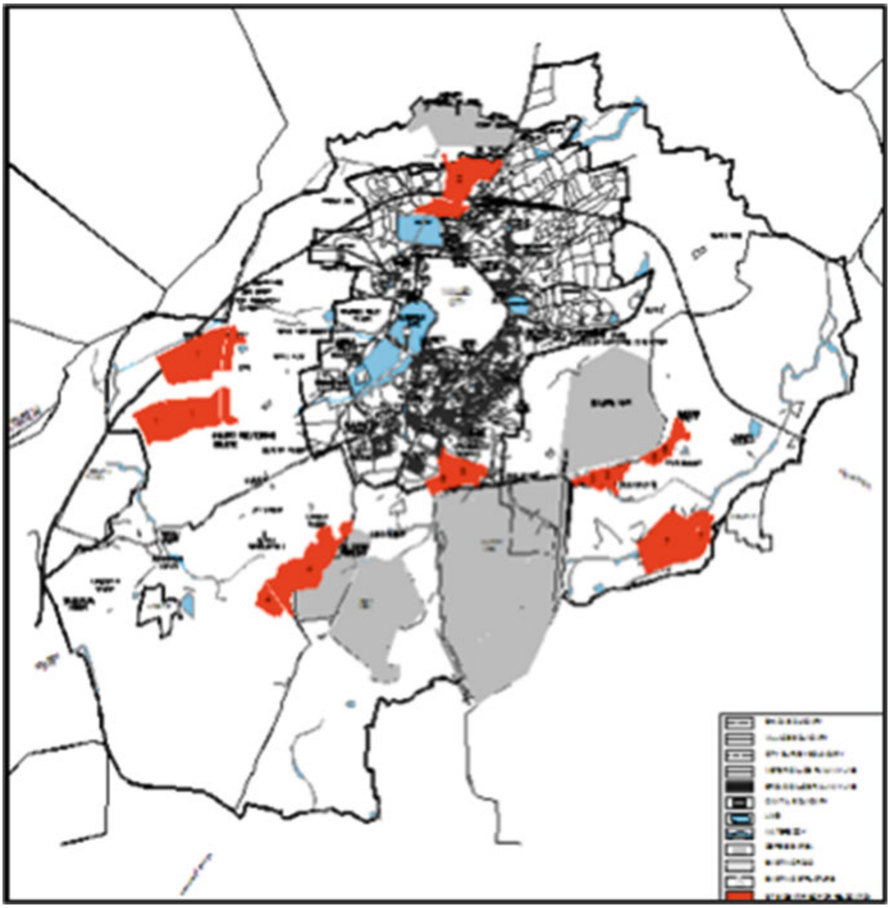

Fig. 4.11 Relocation sites (EPC and GUDC 2001)

Forms were printed for inviting applications for relocation plots and officials were appointed for scrutinizing them. The work on the relocation sites and the entitlement process really took off after a full-time chief executive was appointed in BHADA.

4.4 Planning the Walled City Area: The Next 14 Months

There was a clear consensus among citizens that the Walled City needed to be drastically improved. The main requirement was to enhance safety and enable effective disaster management. For this it was necessary to make the street network more efficient (Fig. 4.12) and create more open spaces. The existing street network was

Fig. 4.12 Conceptual layout of streets inserted in the post-earthquake fabric

full of bottlenecks. At the risk of oversimplifying the issues, it can be said that there were two clear options—widen existing main streets or create new streets by using the space created by collapsed buildings:

1. The first option would have meant demolition of large numbers of standing buildings, particularly the thriving market streets that survived the earthquake. This would have resulted in massive displacement of people and businesses (which are the heart of Bhuj's economy).
2. The second option was clearly the better one not only from the point of view of economy but also from considerations of practical implementation. The development plan published in September 2001 proposed that a set of new wide loop roads be created utilizing open patches of land, giving access to the markets and the entire Walled City, while converting the market streets into pedestrian areas. This approach was endorsed by all levels of decision-making from the general public in Bhuj right up to the chief minister. However, there was a small group of people who felt that the markets should be demolished and widened and that not doing so amounts to "being partisan to commercial interests."

Now there were three options again for realizing the proposed plan:

1. Propose "road lines" (proposed right of way) in the development plan and hope that the roads will be created over many years when buildings are rebuilt, surrendering the additional space required.
2. Acquire the land and buildings coming in the major road alignments through the land acquisition process (leaving the rest of the Walled City as it is).
3. Reorganize all the open plots using the Town Planning (TP) Scheme process (land pooling), improving the plot layout and also creating the new streets.

Having evaluated all options, it was decided to prefer the TP Scheme option as it would create an overall improvement and, at the same time, spread the burden of land/property loss evenly over all affected properties. Displacement would be minimized (EPC and GUDC 2001).

It was a difficult decision for the government to take because urban renewal in such a complex situation had never been attempted before in India and perhaps rarely in the world. In October there were significant changes in the government and finally work on the TP Schemes could start only by the end of 2001.

4.4.1 The Town Planning Scheme Process

The planning process carried out for the redevelopment of the Walled City of Bhuj is perhaps the most complex physical planning exercise ever attempted in India. It consumed over 200,000 h of work by highly qualified professionals using the best available technology, coordinating the work of nearly a dozen organizations and dealing with over 12,000 plots for which over 30,000 persons have ownership claims (Balachandran 2009). What has been achieved is almost unbelievable given the conditions in which the work has been carried out.

Town Planning Schemes are land readjustment schemes where existing plots of land, known as original plots, are reconstituted into final plots, taking away a small portion of land from each plot to create new streets and open spaces. The objectives of the Bhuj TP Schemes were (EPC and GUDC 2002):

1. Enable effective disaster management and reduce loss of life and property in future disasters by creating a more efficient street network
2. Improve the shape of plots and the pattern in which they are laid out, making for more efficient buildings
3. Create more open spaces and space for other utilities

The Town Planning Scheme process consists of three distinct stages (Table 4.2) (Balachandran 2009). The first, known as the Draft TP Scheme, is under the command of the local body—in this case the Bhuj Area Development Authority. At this stage a draft plan is prepared and published for public viewing. After incorporating the objections and suggestions of the owners, the plan is submitted to the state government for sanction. Once the draft plan is sanctioned, the local body can take

Table 4.2 Town Planning Schemes timeline

February 13, 2002	Start of project
	Base map preparation
	Data collection
	Stakeholder consultations
April 24, 2002	Completion of Draft Town Planning Scheme
	Reconstitution of plots
	Preparation of "F form," report
	Owners' meetings
	Publication of Draft Scheme, inviting objections
August 12, 2002	Sanction of Draft Town Planning Scheme
	Formal objections and suggestions from citizens
	Plan revision and finalization
	Submission to the state government, sanction
February 2003	Completion of Preliminary Scheme
	Individual hearings with owners
	Finalization of plan and financial details

possession of the roads and other land allocated for public use. Meanwhile, the state government appoints a town planning officer (TPO). The TPO, a quasi-judicial authority, arbitrates between the owners and the government. Three rounds of individual hearings are given to the owners, and the physical plan—the layout—is finalized. The last stage involves implementation of the physical plan on the ground and resolution of all outstanding issues including financial matters, known as the Final TP Scheme (EPC and GUDC 2002).

4.4.2 Draft Town Planning Schemes

The EPC team started working on the TP Schemes for the Walled City in December 2001 in anticipation of the contract being signed (which happened 2.5 months later). Their work was constrained by the following problems:

1. In September 2001 itself, the consultants had pointed out that the base map and property records of the Walled City were in very bad shape. However, when they started the actual work, the planning team ran into far more problems than they had anticipated.

Fig. 4.13 Plot reorganization seen at neighborhood level (shaded plots are those where buildings survived the quake and blank ones where buildings collapsed) (EPC and GUDC 2002)

2. The total station survey of the Walled City had been carried out in May 2001, when the debris clearance had just started. After the debris removal, the situation had changed considerably. The planning team had to carry out a partial resurvey and work on the base map till early March.

Given the nearly impossible deadline, it was decided to freeze the base map and work on the reconstitution (Figs. 4.13 and 4.14) of open plots so that at least the Draft Town Planning Scheme could be published. Problems remaining were to be solved before submission of the draft schemes to the state government and during the preparation of the Preliminary Schemes. The following policy (Table 4.3) was adopted for deduction of land from open plots.

It was decided that standing buildings would be spared from deduction unless they were affected by proposed road alignments.

In April 2002, the eight Draft TP Schemes were presented to the public at a series of owners' meetings and then published to receive objections and suggestions from the public. Following the publication, the consultants and BHADA in collaboration with the Bhuj Development Council (BDC, an NGO) conducted over 20 meetings for presenting and discussing the schemes with the people. These were well attended and conducted by BHADA with support from the planning team. The Bhuj Development Council established ward offices in each scheme area, displayed maps there and assisted people in filing written responses. They also facilitated creation of neighborhood committees in some areas, but BDC's efforts to create a city-level citizens' committee met with little success.

The people who checked the published maps pointed out both mistakes in the maps and what they felt were errors in judgment. The land deduction policy was well received by the majority of the people. The responses received from people were reviewed case by case and the plans were modified to correct genuine mistakes and to improve the layout.

The government appointed town planning officers 1 month in advance of their actual duty to check the schemes before submission of the schemes to the government for sanction so that mistakes could be minimized. The draft schemes were submitted to the government at the end of July and were sanctioned early in August.

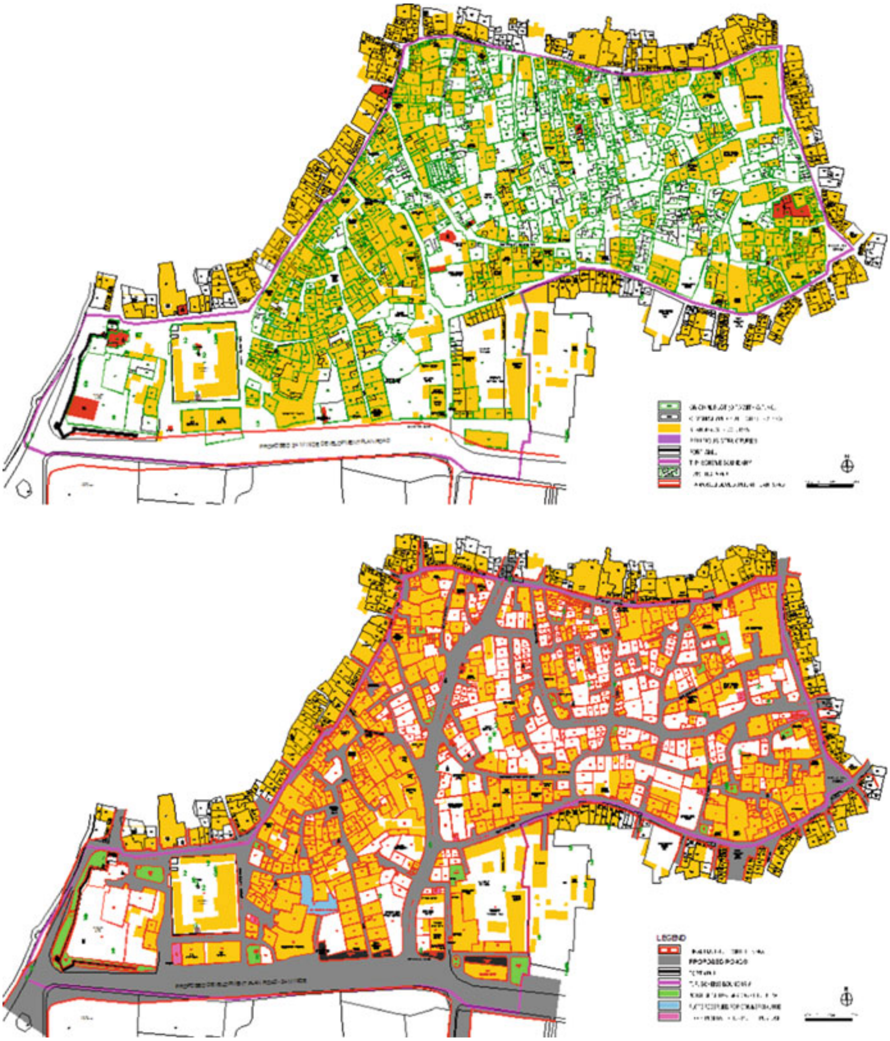

Fig. 4.14 Town Planning Scheme no. 2 (EPC and GUDC 2002)

Table 4.3 Policy for deduction of land

Plots less than 30 m²	No deduction
30–100 m²	10 %
100–200 m²	20 %
200–500 m²	30 %
More than 500 m²	35 %

EPC and GUDC (2002)

4.4.3 Preliminary Town Planning Schemes

The major tasks at this stage were:

1. Finalization of the TP Schemes by the town planning officers
2. Demarcation of major roads and, later, of final plots as finalized by the TPOs.

Thanks to reforms introduced in the Gujarat Town Planning and Urban Development Act in 1998, it had become possible to take possession of road alignments immediately after sanction of draft schemes by the government. Utilizing this provision, BHADA started taking possession of the proposed major roads in the Walled City, issuing notices to the concerned people. The major roads were demarcated by mid-October 2002. It was decided to implement a stretch of highly visible street to send a clear message that the town planning process is firmly underway. Several buildings affected by the proposed road alignments needed to be demolished. This activity was initiated.

Meanwhile, the town planning officers for the eight schemes established office in Bhuj. The TPOs act in quasi-judicial capacity. Their work involves the following stages:

1. Issue notices to individual owners, hear them individually, and make appropriate modifications to the plan.
2. Issue a second notice to the affected parties, hear them again, and make further modifications to the plan.
3. Issue a third and final notice to the affected parties, hear them again, and make finalize the plan.
4. Declare what is known as the "Preliminary Scheme," wherein the physical plan is finalized; issue notices to all owners informing them of the final decision regarding their individual plots.
5. Submit the Preliminary Scheme to the government and get it sanctioned.
6. Prepare and submit the "Final Scheme," which deals with all the financial issues such as compensation, incremental contribution, and cost of works.

The TPOs issued notice for the first hearing to individual owners in early September 2002 and initiated hearings. Despite collaborating with the municipality and local groups, they faced a lot of difficulty in contacting all owners as proper addresses were not available and people had moved out of the Walled City. The second round of hearings was completed by the end of November 2002. Based on the requests made by owners, the TPOs started revising the final plot layout in December 2002. As the layouts got finalized, simultaneously, the final plots were demarcated on the ground. By the last week of January, the layouts were finalized and presented to the BHADA Board for its approval. The demarcation and the final round of hearing were completed by mid-February 2003.

The process of handing over final plots started in the last week of February and continued till the end of March 2003. The completion of one of the TP Schemes was considerably delayed due to litigation. Eventually, the implementation of all eight

Fig. 4.15 Walled City—final layout (EPC and GUDC 2002)

Town Planning Schemes led to a comprehensive transformation of the entire Walled City area (Fig. 4.15).

The pictures below of the worst affected part of the Walled City of Bhuj are testimony to the transformation (Fig. 4.16) that has happened as a result of the implementation of the Town Planning Schemes.

4.4.4 Infrastructure Planning

The development plan at the city level included conceptual plans for infrastructure. The sanction of the development plan was followed immediately by the preparation of detailed plans for city-level infrastructure by the infrastructure design and supervision consultants. Their scope of work included engineering design and packaging and construction supervision of projects for roads, water supply, sewerage, storm water design, and public buildings. Over a period of 2 years, GUDC with local facilitation from BHADA implemented the key improvements proposed in the development plan such as the ring and radial roads, the trunk mains for water supply

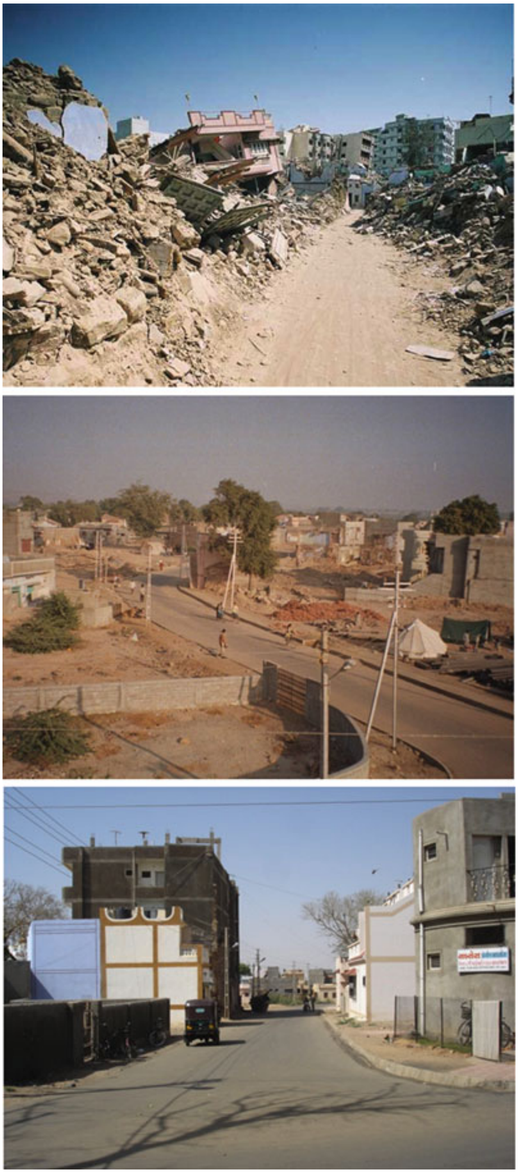

Fig. 4.16 Walled City transformation

and sewerage, etc. One of the interesting aspects of the urban infrastructure design in Bhuj and the other three towns in Kutch is that the networks are designed with features like flexible joints to withstand the effect of ground movements.

The infrastructure networks in the Walled City took much longer to design and implement. The design process started in the mid-2002 when the draft plans were sanctioned and the road network was almost final. The implementation started in the early 2003 and was completed in the late 2004. The design of the system in the

Fig. 4.17 Infrastructure implementation in the Walled City

Walled City was highly complex. A completely new network was being inserted into a densely built inner-city area. Some parts of the Walled City were functional, with homes lived in and businesses working, being served by the old, damaged system. Implementing the new system while people were living there and shops were open was quite a nightmare for the administration. The implementation of the infrastructure (Fig. 4.17) could not have been achieved without the untiring efforts of a very capable team of professionals in the GUDC.

4.5 Bhuj Rising from the Rubble

The reconstruction process picked up pace and started showing results in the mid-2003. In the period that followed, Bhuj saw not only the implementation of the proposals of the development plan and the Town Planning Schemes at a faster pace but they were supplemented by a large number of other initiatives that helped revive the sociocultural life and economy of Bhuj. The prominent streets in the city were quickly developed and provided with streetlights. Many public gardens were renovated and a large new public garden was built on a hill at Rawalwadi near one of the largest relocation sites. Known as the "Hill Garden," this is now one of the most visited public spaces in Bhuj. Several heritage structures were restored including three Walled City gates, the Alfred High School, the vegetable market at Saraf Bazar, etc. A few vignettes (Fig. 4.18) of the transformation caused by the reconstruction are presented below.

Today, the city of Bhuj presents an optimistic picture. It has, almost overnight, transformed from a dusty little district headquarters into a modern urban center. With its brand new infrastructure, Bhuj can now support much faster growth in population and economic activities. A hundred times more investment has gone into physical and social infrastructure in Bhuj over the 4 years following than was invested in the 10 years preceding the earthquake. Most importantly, the citizens of Bhuj are now acquainted with the process of regulated building construction, which we hope will ensure safer construction and mitigate the impacts of a future earthquake.

Fig. 4.18 Bhuj rising from the rubble

4.6 Conclusions

In conclusion some of the key lessons learned are summarized here:

- Land use and physical planning is often neglected during reconstruction as it is seen as time consuming. However, the Bhuj experience shows that a properly structured planning process can, in fact, ensure smooth implementation, thus saving time in the overall process.
- Reconstruction offers a valuable opportunity to introduce systemic changes in development planning and regulation, reducing long-term disaster risk. If this window of opportunity is utilized, the benefits far outweigh the cost and fully justify the effort.

- Opening up the land market through land use planning and infrastructure development reduces pressure in the real estate market, consequently reducing windfall gains from violation of rules, eventually resulting in safer construction and risk reduction.
- The trade-off between time required, quality of work, and level of public participation is inevitable in the post-disaster reconstruction process. The true challenge before political leaders and bureaucrats is the negotiation of this trade-off in a transparent manner, taking the people along.
- Structuring the reconstruction process and putting in place the appropriate institutional arrangements are extremely crucial. The involvement of experts with reconstruction experience at this stage is most beneficial.
- Continuity in decision-making is extremely critical in any process of this kind. Frequent changes in administrative and technical positions caused avoidable delays. However, the overall commitment of the government to stay the course was critical in the success achieved.
- As far as possible, the reconstruction process should be undertaken using existing legal and institutional mechanisms. The disaster should be made an opportunity to strengthen and streamline these systems.
- The importance of maintaining accurate maps in all our cities cannot be overemphasized. There is a Bhuj waiting to happen in every Indian city—if not an earthquake, it will be a fire or a flood. The institutional architecture for mapping and maintaining land records in cities needs to be drastically altered and a large campaign launched to catch up on lost time.
- In the post-disaster situation, it is important to show results fast and continuously. Many of the proposals in the development plan could have been taken up for implementation while the planning for the Walled City was going on, particularly those that had economic benefits to the city.

To reiterate, despite all the problems that have been listed here, the reconstruction of Bhuj can truly be considered one of the landmark post-disaster projects in the world. In no small measure is the credit for this due to the absolute commitment shown by the government machinery in making Bhuj a model for other cities to follow (Balachandran 2011).

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Chapter 5
Land Use Management Along Fault Line: Experiences of New Zealand

Michiko Banba

Abstract New Zealand's land use management for disaster mitigation is based on the idea of the sustainable management of natural and human resources, and disaster is considered one of the natural environment factors. The current framework was formulated with the enforcement of restructure of the governments, law reform, and privatization of public service, and decentralization of power provides local governments with the authority to implement land use management for disaster mitigation. In this chapter, New Zealand's land use management for disaster mitigation is analyzed, and issues are discussed from the perspective of legal and administrative framework. It is found out that understanding of natural hazard and risks makes it useful in land use planning and management to control developments.

Keywords Land use management • Land use plan • Fault • Resource Management Act

5.1 Introduction

New Zealand has implemented land use management based on the risk assessment. Resource Management Act, which is the main legislation for land use management, plays the important role on it. In this chapter, land use management considering earthquake disaster risk, especially fault line, is discussed. Two cases from Wellington City and Upper Hutt City are studied to clarify the effectiveness of land use management through the implementation of RMA.

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5.2 Legal System of Land Use Management for Disaster Risk Reduction

New Zealand has to deal with various kinds of natural hazards including earthquake, tsunami, flooding, or volcanic eruption. Natural hazards each local authority faces differ; thus, it needs to develop disaster management strategies by its own. For the city of Wellington, the Wellington fault has been thought to cause a serious earthquake disaster in the future. Land use planning and management considering natural hazards is one of the disaster management tools from the long-term perspective.

To address environmental issues including natural hazards in an integrated and comprehensive manner, New Zealand established the Resource Management Act (1991). The Act is intended to resolve conflicting or overlapping laws on environmental protection, pollution, disaster risk reduction, and urban development. It considers the ecosystem and human activities to be inseparable and addresses both simultaneously and comprehensively. In particular, the Act consolidates different laws on land, air, water, soil, biodiversity, coastal environmental, noise, subdivisions, and land use planning into single and simple environmental laws in order to utilize, develop, and restore natural, physical, and construction environments.

At the same time, the Town and Country Planning Act (1977) and other laws were abolished or revised and integrated into the Resource Management Act. Under the Town and Country Planning Act, the central government took initiative in providing technical and financial support to local governments in the field of land use planning, and local governments implemented policies based on the principles set by the central government. The central government had the authority over urban planning, but municipal governments were given discretionary power over implementation of district plans (Rae 2002). The district plan contains a land use plan or zoning plan with rules and regulations for land use. This arrangement minimized the intervention of private business, and necessary items to obtain permission were written in the statutory form, reducing the discretionary power of municipal governments. Additionally, a result-oriented policy and promotion of ex post evaluation shifted the role of municipal governments from active regulation and instruction to management of effects. On the other hand, a system of resource consent, which is outlined in the Resource Management Act, ensures the discretionary power of municipal governments within the framework set in the district plan.

Over time as technical and financial support became increasingly difficult at the national level, local governments were given more responsibility and authority in policy making, and the central government's role shifted to evaluation and management. Upon enacting the Resource Management Act, the Ministry for the Environment's role became to mainly providing policy advice to support local governments and monitoring the effects of local policies. Under the Act, regional governments are required develop a regional policy statement (or regional plan if necessary) on broad-based environmental management, while municipal governments, who continue to be responsible for land use and regional planning, are required to develop a district plan, control development effects, and engage in land use management.

5.2.1 Land Use Planning and Management

As mentioned earlier, the Resource Management Act is central to land use management for disaster risk reduction. According to the Act, natural disasters and their impact on local communities are environmental problems, and policies on disaster risk reduction are part of environmental management. In such a comprehensive approach, land use management plays an important role in environmental management. By effectively implementing land use management, the Act aims to reduce the environmental burden and risk to local communities.

Resource consent is a key measure in implementing a district plan, which must be developed under Section 72 of the Act. There are five types of resource consent: land use consent, subdivision consent, water permit, discharge permit, and coastal permit. This system gives permission with conditions for utilization and development of natural and material resources or activities that may impact the natural environment. Resource consent is granted by regional councils and territorial authorities (Minister of Environmental Agency on the national level), which are collectively known as consent authorities.

Consent authorities ensure that communities and applicants work together while avoiding, remedying, or mitigating any adverse effects of activities on the environment. They also monitor the conditions of consent after the activities are complete to ensure a thorough implementation.

It is noteworthy that consent authorities reduce the responsibility of public administration on development activities. The Resource Management Act does not require administrative organizations to oversee every aspect. Instead, it creates more room for applicants to enact spontaneous eco-friendly measures within the framework of preservation and the system of information sharing on land given by the public administration. The Act is also designed to enable a flexible planning process in which the results of the development activities and not the land are assessed to promote sustainable management of the environment (Sect. 5).

This setup results in an organic link between resource impact assessment and planning.

The 2003 amendment to the Resource Management Act sets additional requirements including (a) reduction of law compliance costs to acquire resource consent, (b) establishment of national environmental standards, and (c) protection of historic buildings (New Zealand Ministry for the Environment 2004a).

5.2.2 Building Codes

The Building Act (1991) stipulates that almost all buildings must apply for building consent. The Building Act not only establishes earthquake-resistant construction standards but also identifies earthquake-prone buildings, orders eviction or building reinforcement, and inhibits building consent in areas that have ground subsidence or slippage hazards. Section 66 deems buildings constructed of unreinforced concrete or unreinforced masonry to be earthquake-prone and sets standards for constructing these types of buildings in areas with high earthquake hazards (4). These standards apply to all housing complexes with two or more stories or three or more household units. Low-rise private houses are excluded. Section 36 stipulates that municipal governments may grant building consent if development is proven not to impact the land (environment) with potentially high earthquake hazards, while refusing to grant building consent for buildings on land subject to subsidence or slippage. Hence, Sections 36 and 66 are as effective as the Resource Management Act in implementing a district plan in the municipal government.

Applicants can obtain disaster information that may affect buildings on planned sites through the Project Information Memoranda provided by municipal governments (Sections 30 and 31).

5.2.3 Disclosure of Hazard Information

The Local Government Official Information and Meetings Act (1987) stipulates that land information (including geology, faults, and other earthquake-related information) held by local governments must be disclosed by plot to applicants in the Land Information Memoranda (Section 44).

5.3 Planning System for Disaster Risk Reduction

5.3.1 District Plans

A district plan consists of a zoning map and policy statements that include disaster information on earthquake hazards such as faults and liquefaction. The plan shows the objectives, policies, countermeasures, and rules to each zone. Each district plan sets its own (1) objectives, policies, and rules; (2) design guides; and (3) zoning map. For example, Wellington City's district plan (2000) has three noteworthy characteristics as a tool for disaster risk reduction with regard to fault lines and neighboring buildings: (a) height restrictions, (b) population density and reduction of development strength (inhibition of housing complexes), and (c) standards that are

Table 5.1 Types of resource consents

Activities	Consent required	Notes
Permitted activities	No	Activity allowed without a consent
Controlled activities	Yes	Authority must grant consent, but may impose conditions in some matters
Restricted discretionary activities	Yes	Authority may deny or grant consent, with conditions, but only decided on matters set out in the plan
Discretionary activities	Yes	Authority has full discretion to deny or grant consent and may impose conditions
Non-complying activities	Yes	Authority may deny or grant consent, where effects are minor and activity not inconsistent with plan
Prohibited activities	N/A	Plan change required to reclassify

stricter than the building code (NZ Standard 4203: 1992) (Wellington City Council 2000, 2004).

5.3.2 *Guidance for Construction and Development Based on Resource Consent and Building Consent*

The Resource Management Act requires municipal governments to collect local hazard information. Some municipal governments create and publicize maps of areas with high earthquake hazards, including fault ruptures, seismic movement, and liquefaction. Others even restrict development in such areas. Municipal governments can manage land use flexibly by effectively utilizing the Resource Management Act and the Building Act.

Table 5.1 summarizes construction and development by the six levels of resource consent. Earthworks and residential land development require applications for resource consent in addition to building consent (equivalent of alterations to land zoning quality in the development permission system in Japan). Applicants must take the steps listed below. If applicants have an objection, they can appeal to the environmental court:

(a) Check the district plan of the land scheduled for development activity.
(b) Verify the construction/development category of the proposed development activity.
(c) Consider necessary actions if resource consent is required.
(d) Provide documentation that identifies the environmental impact of the development activity if assessment of the environmental impact is necessary. (Review the development activity as necessary.)

For example, the current Wellington City district plan (2004) considers fault lines and surrounding areas as hazardous. In the plan, constructing a building that is 8 m or lower is a "permitted activity," while constructing a building taller than 8 m is a “restricted discretionary activity.” Additionally, constructing a housing complex with two or more houses on one site is a “discretionary activity.” If the impact caused by a development activity is deemed to violate the district plan (New Zealand Ministry for the Environment 2004b), it is a “prohibited activity” (height restriction and the number of houses per site were amended in 2004) (Wellington City 2004).

5.4 Examples of Land Use Management

This section examines cases in Wellington City and Upper Hutt City with an emphasis on relevant development activities in built-up areas and new residential areas.

5.4.1 Built-Up Area (Wellington City)

The Wellington fault runs through built-up areas of Wellington (Fig. 5.1). The district plan clearly marks the width of the hazard areas by the fault rupture location. In addition to a height restriction of 6 m, the city’s district plan (1997) stipulates that

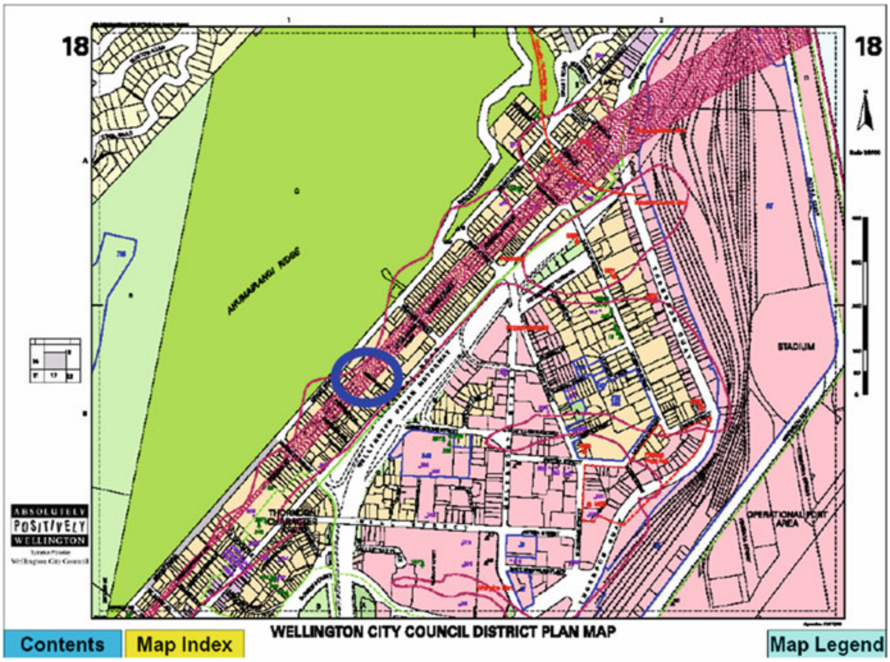

Fig. 5.1 District map of Wellington City (Source: Wellington City)

the construction of more than three new houses in a hazard area must obtain land use consent.

For example, one case of "restricted discretionary activity" called for building 17 residential houses. Because 11 of the houses were in a hazard area, and four of which exceeded the 6-m height restriction, land use consent was necessary. The case received approval after negotiating the following conditions:

(a) Construction is not permitted unless the geological condition is consistent with a geological survey report provided by a registered engineer.
(b) Building construction NZS4203:1992 is applicable.
(c) Site planning must secure open space and improve access by car.

This case demonstrates that land use management according to the Resource Management Act is based on result-oriented agreement conditions to access the impact of development and is remarkable in the way that it responds to individual development cases as it allows room to negotiate. It is also noteworthy that regulations are implemented by overlaying the fault line belt on the zoning plan rather than zoning for specific purposes by taking earthquake risks into consideration. This makes it easier to respond to newly identified or revised fault lines.

Wellington City has actually reexamined its district plan based on the latest studies and publicized their approaches to the general public in 2003. In 2004, the city reidentified fault lines and buffer areas and changed its regulations accordingly (Wellington City 2004).

5.4.2 New Residential Area (Upper Hutt City)

Upper Hutt City, which is located 30 km northeast of Wellington City, has been developing residential areas away from the Wellington fault lines (Fig. 5.2). One case is the development of Totara Park, which is located on the other side of the Hutt River in the city center. The development of residential areas started toward the end of the 1960s. The initial plan prohibited construction of residential areas in the fault rupture hazard area. Only wide straight roads and parks were allowed in these hazard areas.

Under the Town and Country Plan, the 1965 Upper Hutt Borough District Scheme considered the location of the fault rupture relevant information when determining land use, and the city also provided instructions on the location at the time of development (interview with a city officer). This was actually before California's Alquist-Priolo Earthquake Fault Zoning Act (1972) and is one of the earliest examples of managing use of land above an active fault line when developing such land into a residential area. To date, the city continues to provide regulations on seismic faults in its district plan and specifies the faults on a map.

According to the district plan based on the Resource Management Act, constructing new habitable buildings in the 40-meter-wide fault line and buffer area specified on the map is a "discretionary activity," and it is effectively impossible to

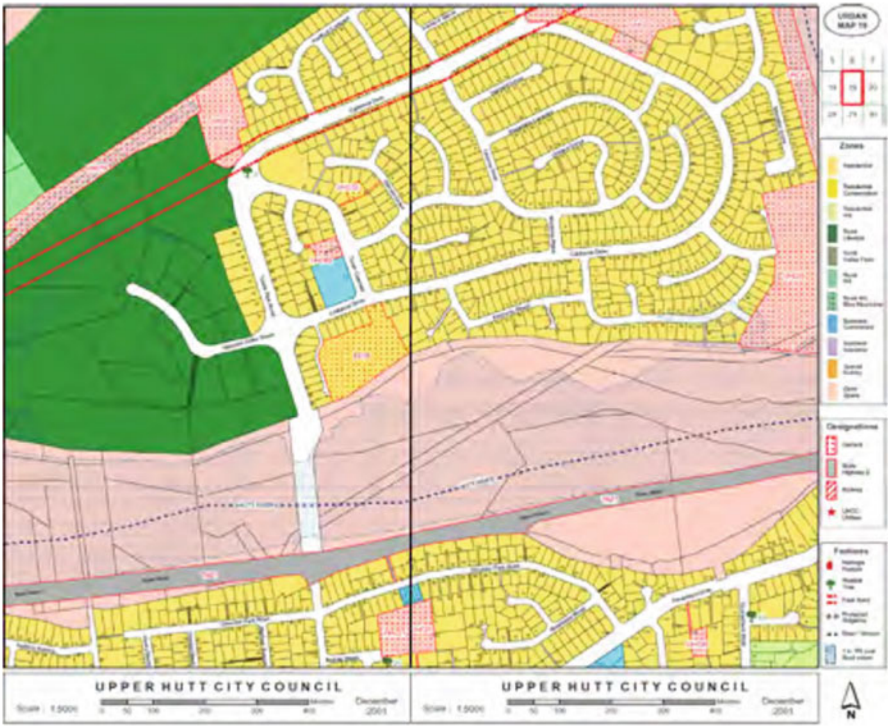

Fig. 5.2 District map of Upper Hutt City (Source: Upper Hutt City)

gain consent (interview with a city officer). Similar to the case of Totara Park, wide roads are above the active fault line in Emerald Estates, which was developed several years ago, indicating that residential areas have been developed away from the fault line.

5.5 Evaluation of Land Use Management for Disaster Risk Reduction in New Zealand

5.5.1 Characteristics of Land Use Management for Disaster Risk Reduction of NZ

The characteristics of land use management for disaster risk reduction in New Zealand are summarized as follows:

(a) District plans provide mandatory information disclosure on seismic hazards and a legal foundation for utilizing hazard information.
(b) Local governments take initiative in disaster risk reduction.

(c) A comprehensive framework based on the Resource Management Act exists.
(d) The system, which utilizes district plans and resource consent, provides flexibility.
(e) Decisions about development activity are based on impact analysis.
(f) Building structures are determined based on coordination of the Resource Management Act and the Building Act.
(g) The system requires developers' voluntary efforts.

The examples of development activities above the active fault line in two cities reveal that (a) in built-up areas, strict land use control is difficult to enforce and address in a practical manner, but (b) in newly developed areas, strict land use control can be practically enforced. Regardless of the level the development, the city has discretionary power and can respond flexibly according to reality of the community, including the residents' potential understanding and acceptance of the regulations. This is crucial for effective implementation of the system.

5.5.2 Comparison with California's System

The state of California is the other case implementing land use regulation along with fault line although its practice is different from the one of New Zealand. Those two cases are compared to analyze differences to clarify their distinctive features.

The state of California has been engaged in land use management for disaster risk reduction based on the Alquist-Priolo Earthquake Fault Zoning Act and the Seismic Hazard Mapping Act. Both California and New Zealand have construction regulations near active fault lines, and their legal framework is reflected in district plans. The main difference is that California's land use management is coercive, whereas New Zealand's approach is cooperative (May et al. 1996). This is because the Alquist-Priolo Earthquake Fault Zoning Act and the Seismic Hazard Mapping Act stipulate regulations and obligations, while the Resource Management Act basically leaves regulatory policies to the discretion of the city. The Alquist-Priolo Earthquake Fault Zoning Act requires all inhabited buildings, except for private houses, to be set back from the fault line.

On the other hand, the Resource Management Act provides development procedures based on resource consent, leaving agreement conditions to the discretion of each municipality and the capacity of the developer. The California state government applies the Zoning Act and the Seismic Hazard Mapping Act as the minimum standards for land use management for disaster risk reduction, although the municipal-level authority remains strong. Moreover, California has more specific development standards for zoning than New Zealand. Some Californian cities even have zoning plans that reflect hazard information (interview with San Jose city officer).

Comparing the characteristics of land use management-related laws shows that California laws respond to a single purpose and a single disaster, while the Resource

Management Act takes a more comprehensive approach to disaster at large. Hence, the Resource Management Act is a progressive law system that reflects the growing importance of multi-hazard disaster risk reduction in which all disasters are considered in an integrated manner. However, California receives support from various disaster risk reduction programs from the Federal Emergency Management Agency, which is part of the federal government, while the financial or technical support from higher government levels is decreasing in New Zealand (May et al. 1996).

5.5.3 Problems and Solutions

New Zealand's environmental policy based on the Resource Management Act has some issues. Although the idea of an integrated management of environment is ideal, it imposes a burden on the municipal government in terms of staff, financial resources (including negotiation cost), and technology. These burdens create a gap in the actual implementation by municipality. Unlike California's Alquist-Priolo Earthquake Fault Zoning Act, the Resource Management Act fails to provide specific regulations, leaving regulatory policies to the discretion of the city, which may cause discrepancies between resource consent and building consent.

As Grundy and Glesson (1996) and Robertson (1996) point out, marketization of the environmental policy is becoming increasingly controversial. Grundy and Glesson (1996) claim that privatization and marketization by governmental agencies may create controversy when protecting the natural environment, which is traditionally a public endeavor, because the conflict between sustainable environmental management and marketization is not resolved.

Furthermore, national standards or policies to identify and reduce hazards do not exist in New Zealand, especially when dealing with active fault lines. This raises concerns that variations in municipal capacities will widen the implementation gap of the Act. Nathan, the president of the Geological Society of New Zealand, has listed the following shortcomings of the Act: (a) a lack of organic linkages between natural science information and land information, (b) underdevelopment of national guidelines for utilizing disaster hazard information in district plans, (c) underdevelopment of national guidelines for construction activities near active fault lines, (d) adjustment of regional and national measures on active fault lines, and (e) lack of integrated work at the national level. Nathan further argues for (a) adding measures on active fault lines to the existing criteria to determine the best municipal-level practices, (b) advancing policy statements and policy making at a national level, (c) creating national standards to identify and map active fault lines in district plans, and (d) examining California's Seismic Hazard Mapping Act (Nathan 2004).

In 2001, the Ministry for the Environment and the Parliamentary Commissioner for the Environment published a report based on an independent environmental policy evaluation (Office of Parliamentary Commissioner for the Environment 2001). The evaluation called for practical guidelines to avoid and reduce risks caused by a fault rupture. In 2003, the Ministry for the Environment published

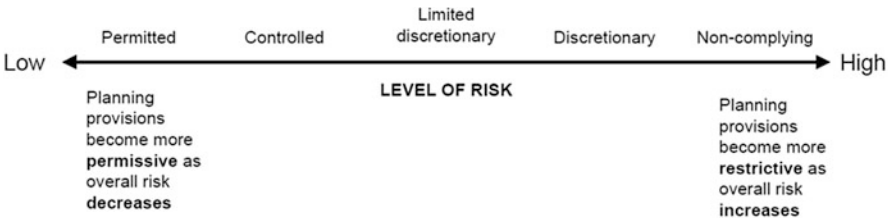

Fig. 5.3 Risk level and resource management

"Planning for Development of Land on or Close to Active Faults: An Interim Guideline to Assist Resource" (New Zealand Ministry for the Environment 2003), suggesting four principles by referring to the cases introduced in this paper as well as other examples:

(a) Collect and map accurate information about hazards due to active fault lines.
(b) Design measures to avoid fault rupture hazards when initiating new development or subdivision of land (e.g., restricted construction in fault rupture areas).
(c) Introduce a risk-based approach for existing development or subdivision of land (risk management standard AS/NZS 4360: 1999).
(d) Promote risk communication in fault rupture areas within built-up areas.

Each of these measures is practical within the framework of land use management for disaster risk reduction. Guidelines (b) and (c) correspond to resource consent (Fig. 5.3). In addition, the guidelines suggest drafting proposals to show how fault line activity (cycle) × fault trace complexity and complexity × building importance category (BIC) correspond to resource consent for each of the newly developed and built-up areas (Fig. 5.3 and Tables 5.2 and 5.3: Risk level and resource consent (New Zealand Ministry for the Environment 2003) for new developments). Especially for (d), non-regulatory responses to land under risk have been suggested. Options include purchasing land for recreational purposes, exchanging land, setting premiums for development rights for other lands, providing funds to encourage landowners to voluntarily vacate land near active fault lines, increasing education and information, and raising quake-resistance standards.

These guidelines should provide criteria for judgments to local governments, reducing the discretional gap in resource consent and building consent. On the other hand, this type of formalization may restrict the discretion of local governments guaranteed under the resource consent system.

5.6 Conclusion

In this chapter, land use management for disaster reduction in New Zealand is discussed focusing on land use along the fault line. It is implemented under the framework of environmental management which integrates natural environment and land

Table 5.2 Relationship of building importance, recurrence, and resource consents

Fault complexity	Building importance categories				
	1	2a	2b	3	4
Class I recurrence interval <2000 years					
Well defined	Permitted	Non-complying	Non-complying	Non-complying	Prohibited
Distributed	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
Uncertain	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
Class II 2000 years < recurrence interval <3500 years					
Well defined	Permitted	Prohibited	Non-complying	Non-complying	Prohibited
Distributed	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
Uncertain	Permitted	Discretionary	Non-complying	Non-complying	Non-complying
Class II 2000 years < recurrence interval <3500 years					
Well defined	Permitted	Permitted	Non-complying	Non-complying	Non-complying
Distributed	Permitted	Permitted	Discretionary	Discretionary	Non-complying
Uncertain	Permitted	Permitted	Discretionary	Discretionary	Non-complying
Class II 2000 years < recurrence interval <3500 years					
Well defined	Permitted	Permitted	Permitted	Non-complying	Non-complying
Distributed	Permitted	Permitted	Permitted	Discretionary	Non-complying
Uncertain	Permitted	Permitted	Permitted	Discretionary	Non-complying
Class II 2000 years < recurrence interval <3500 years					
Well defined	Permitted	Permitted	Permitted	Permitted	Non-complying
Distributed	Permitted	Permitted	Permitted	Permitted	Non-complying
Uncertain	Permitted	Permitted	Permitted	Permitted	Non-complying
Class II 2000 years < recurrence interval <3500 years					
Well defined	Permitted	Permitted	Permitted	Permitted	Non-complying
Distributed	Permitted	Permitted	Permitted	Permitted	Non-complying
Uncertain	Permitted	Permitted	Permitted	Permitted	Non-complying

(continued)

Table 5.2 (continued)

Fault complexity	Building importance categories				
	1	2a	2b	3	4
Class II 2000 years < recurrence interval <3500 years					
Well defined	Permitted	Permitted	Permitted	Permitted	Permitted
Distributed	Permitted	Permitted	Permitted	Permitted	Permitted
Uncertain	Permitted	Permitted	Permitted	Permitted	Permitted

Source: New Zealand Ministry for the Environment (2003)

Table 5.3 Building importance categories

Building importance category (BIC)	Description	Examples
1	Structures presenting a low degree of hazard to life and other property	Structures with a total floor area of less than 30 m^2
		Farm buildings, isolated structures, and towers in natural situations
		Fences masts and walls in ground swimming pools
2a	Residential timber-framed construction	Timber-framed single-story dwellings
2b	Normal structures and structures not in other categories	Timber-framed houses of plan area of more than 300 m^2
		houses outside the scope of NZS 3604 “Timber-Framed Buildings”
		Multi-occupancy residential, commercial (including shops), and industrial office and retailing buildings designed to accommodate less than 5000 people and also those less than 10,000 m^2 gross area
		Public assembly buildings, theaters, and cinemas of less than 1000 m^2
		Car parking buildings

(continued)

Table 5.3 (continued)

Building importance category (BIC)	Description	Examples
3	Structures that, **as a whole**, may contain people in crowds or contents of high value to the community or pose **risks to people in crowds**	Emergency medical and other emergency facilities not designated as post-disaster facilities
		Buildings where more than 300 people can congregate in one area
		Buildings and facilities with primary school, secondary school, or day care facilities with capacity greater than 250
		Buildings and facilities with capacity greater than 500 for colleges or adult education facilities
		Health-care facilities with a capacity of 50 or more residents but not having surgery or emergency treatment facilities
		Airport terminals and principal railway stations, with a capacity of more than 250 people
		Any occupancy with an occupancy load greater than 5000
		Power-generating facilities, water treatment and wastewater treatment facilities, and other public unities not included in importance category 4
		Buildings and facilities not included in importance category 4 containing hazardous materials capable of causing hazardous conditions that do not extend beyond the property boundaries
4	Structures with special post-disaster functions	Buildings and facilities designated as essential facilities
		Buildings and facilities with special post-disaster function
		Medical emergency or surgical facilities
		Emergency service facilities such as fire, police stations, and emergency vehicle garages
		Utilities required as backup for buildings and facilities of importance level 4
		Designated emergency shelters
		Designated emergency centers and ancillary facilities
		Buildings and facilities containing hazardous materials capable of causing hazardous conditions that extend beyond the property boundaries

Source: New Zealand Ministry for the Environment (2003) development in comprehensive manner, and the Resource Management Act is legislated for that purpose. This system is considered an advanced effort in terms of effectiveness and practicality. In spite of tits superiority, this system does not necessarily work in every country. Each country needs to develop the original system for land use management for disaster reduction within its own social and economic system. However, there are some common aspects which can be useful in everywhere as follows:

– Importance of disclosure of hazard risk information and risk communication
– Evaluation and adaptation of hazard information in land use planning
– Consideration of hazard information in development and building permission
– Definition of each role of concerned entities

Understanding of hazard and risks is the first step for land use management for disaster reduction to find out suitable system to make it work in each country.

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Chapter 6
Experience from the United States: Post-Katrina and Sandy

Post-disaster Land Use Management After Hurricane Katrina and Superstorm Sandy in the United States

Elizabeth Maly, Tamiyo Kondo, and Michiko Banba

Abstract Land use management in the United States is decided at the local level and not directly controlled by disaster recovery plans and policies. However, disaster mitigation and recovery policies and initiatives are closely connected to and influence land use patterns. After Hurricane Katrina in 2005 and Superstorm Sandy in 2012, recovery policies and programs had direct and varied impacts on land use in the affected areas, where, as part of recovery programs after both disasters, government buyouts have been used to purchase houses and property. In terms of implications for land use, the main difference between buyouts after Hurricane Katrina and Superstorm Sandy is if programs targeted damaged houses individually or by area. As damaged houses and lots were acquired individually in New Orleans after Katrina, vacant lots were left scattered throughout the city. To avoid similar outcomes after Sandy, New York City focused on property acquisition for redevelopment, and New York State's buyout programs also targeted clusters of damaged houses and properties in coastal areas. After Sandy, new initiatives to address land use issues and resilience were also introduced through the Rebuild by Design (RbD) program, which began as an unprecedented design competition to consider resilience issues at a regional scale and was funded through a combination of public and private support. In addition to the geographical, political, and development contexts, the timing of Sandy recovery coincides with an ongoing processes of flood map updates and flood insurance reforms, which are closely linked to housing recovery as well as existing and evolving patterns of land use in affected areas.

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6.1 Introduction

Land use decisions in the United States are primarily controlled at the local government level. Although federal and state-level disaster recovery policies do not directly control local land use, national policies related to disaster risk reduction and recovery significantly impact land use decisions. Land use management patterns after recent major natural disasters in the United States are closely tied to the National Flood Insurance Program (NFIP), disaster recovery assistance, and mitigation programs.

In August 2005, Hurricane Katrina caused devastation along the Gulf Coast. In New Orleans, levees that had not been built to sufficient standards were breached and failed, causing long-term flooding and massive damage to the city, which lies below sea level between the Mississippi River and Lake Pontchartrain. Seven years later, Hurricane Sandy was downgraded to a superstorm when it made landfall on the east coast of the United States, causing massive damage. The housing recovery after these two flood disasters occurred within the same national framework of disaster assistance, but with different impacts on land use patterns. Post-disaster land use after Sandy has several distinctive features that differ from land use patterns in New Orleans after Hurricane Katrina.

Primary initiatives related to land use management for disaster resilience in communities after Superstorm Sandy include residential buyout programs, updated flood maps and implementation of revisions to the National Flood Insurance Program (NFIP), and projects from the Rebuild by Design program. Residential buyouts for disaster mitigation, “voluntary buyouts of repetitive loss property,” in which the government purchases residential property, demolishes houses, and preserves the property in conservation (Boyd 2014), have been used in the United States for several decades, and residential buyouts also played a role in housing recovery support in New Orleans after Hurricane Katrina. Although residential buyout programs after Superstorm Sandy affect only a limited number of residents, the use of varied and multiple residential buyout programs deserves attention as a means for disaster mitigation through modification of land use patterns.

Federally funded housing recovery policies in the United States focus on preventing the loss of property, especially recurring losses; this principle guides disaster assistance including property buyout programs. Residential buyouts represent only a small fraction of recovery projects; homeowners facing decisions about housing repair or reconstruction after disaster are more likely to be impacted by housing elevation requirements, which are in turn closely tied to flood insurance regulations and related flood maps.

This chapter considers the ways recovery policies after Hurricane Katrina (2005) and Superstorm Sandy (2012) incorporate risk-based land use planning, primarily in the form of residential buyouts as part of housing recovery support, and potential impacts on affected communities and rebuilding households. The historical context for post-disaster recovery planning and federal funding for mitigation measures related to land use management has been shaped by the Hazard Mitigation Grant Program; the National Flood Insurance Program (NFIP) and related regulations also play key roles, especially as the timing of major revisions to the NFIP coincides with post-Sandy recovery. This chapter explains the background of these national policies and their relationships to recovery programs after Hurricane Katrina and then after Superstorm Sandy.

6.2 Key US Federal Policies Related to Land Use Management for Flooding

Floodplain management, including zoning, land development regulations, and designation of easements for areas at risk of flooding, is the responsibility of local jurisdictions; the US federal government does not regulate local land use management directly. However, several key federal regulations and programs significantly impact land use management before and after flood disasters and require disaster prevention measures in order to receive federal funding (Schwab 2014, Smith 2012). This section provides an overview of these programs, including the National Flood Insurance Program (NFIP) and flood risk maps created by the Federal Emergency Management Agency (FEMA), the Hazard Mitigation Grant Program (HMGP), and their relationship to land use and disaster risk and recovery.

6.2.1 National Flood Insurance Program (NFIP)

6.2.1.1 Historical Development of the NFIP Since 1968

Although 90 % of all US disasters involve flooding, homeowners' insurance policies for wind, fire, or theft do not usually cover flooding; private insurance companies are not willing to provide coverage because of the "catastrophic nature of flooding and inability to adequately predict risks" (GAO 2014). After multiple and severe flood disasters and increased cost of providing disaster assistance to uninsured residents, the National Flood Insurance Program (NFIP) was created by the National Flood Insurance Act of 1968, with the goal of reducing future losses. The NFIP made federally backed, low-cost flood insurance available to residents on the condition that local governments pass floodplain ordinances (Haddow et al. 2013), and subsidized insurance premiums since many affected people have lower incomes

(Haddow 2013). This Act started one of the largest federal flood-mapping efforts in the United States, as the government promised to provide local governments "technical tools to determine where the floodplains were in their communities so they could steer development away from these areas" (Haddow 2013). In 1973, the NFIP was significantly revised to require purchase of federal flood insurance for any federally backed loan, and the pressure from residents who wanted access to these loans caused communities to pass the required ordinances and join the NFIP (Haddow 2013).

6.2.1.2 Impact of NFIP Requirements on Building Construction, Households, and Recovery

The NFIP requires participating communities to adopt building codes based on flood risk assessments and Flood Insurance Rate Maps (FIRMs) created and revised by FEMA.[1] NFIP regulations directly impact individual households in the two following ways: (1) Housing construction must comply with local building codes based on Flood Insurance Rate Maps (FIRMs); and (2) Homeowners in flood zones are required to purchase flood insurance. After a disaster, revised local building codes based on updated flood maps may require homeowners rebuild to a new higher elevation[2] or with a more flood-proof foundation; waiting for updated regulations may also delay personal household recovery. Because reforms were already underway, recovery after Sandy coincides with the implementation of significant changes to NFIP and insurance premium increases.

Homeowners in communities participating in NFIP are required to carry flood insurance if their property is in a flood zone; the purchase of flood insurance for these properties is mandatory for any federally backed loan or mortgage. If homeowners do not purchase and keep required flood insurance policies current, they are ineligible for federally funded recovery support after a disaster, including for housing repairs or reconstruction. However, NFIP insurance is not available to homeowners who are *not* in designated flood risk zones; these homeowners can receive federal government support in case of flood damage. When flood maps are updated after a disaster, homeowners may also be newly required to purchase flood insurance if their area has been rezoned. Figure 6.1 shows the relationships and roles of actors involved in NFIP.

[1] In coastal areas the FIRMs specify Special Flood Hazard Areas (SFHAs), including two primary zones: zone VE and zone AE. In zone VE, also known as the Coastal High Hazard Area, the estimated wave height is 3 ft or higher; the wave height is lower than 3 ft in the coastal zone AE (FEMA Region II 2016).

[2] Base flood elevation, or BFE, is calculated as the number of feet above the sea level of the first (entry) floor of the building. As a safety factor, communities can include freeboard, an additional height in addition to BFE. Encouraged but not required by the NFIP, freeboard results in significant reductions in flood insurance rates. As part of the process to update FIRMs, preliminary FIRMs are issued and, before that, Advisory Base Flood Elevations (ABFEs), which show the direction that future flood mapping will take.

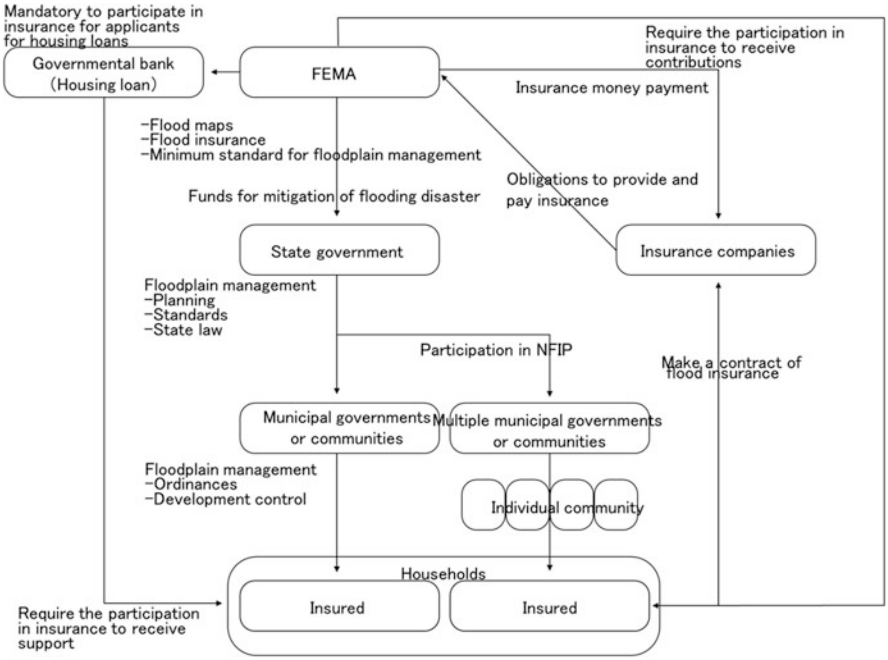

Fig. 6.1 National flood insurance program actors and relationships

6.2.1.3 Budget Issues and Recent Revisions to NFIP

The design of the NFIP, which heavily subsidizes insurance premiums that do not reflect actual flood risk and then makes large and multiple payouts, has left the program deeply in debt (Meyer 2013, National Wildlife Federation 1998). After Hurricane Katrina in 2005, the NFIP borrowed more than $20 billion to pay flood claims; as of December 2013, the NFIP owned the US Treasury $24 billion, most of which had been borrowed to pay for claims after Katrina and Sandy (GAO 2014). To address NFIP's flaws—inadequate coverage requirements and chronic budget shortfalls—the 2012 Biggert-Waters Law proposed reforms to NFIP (Knowles 2014). Bigger-Waters (BW) stipulated that (1) properties built before the NFIP would no longer be exempt, (2) coverage would be denied for repetitive loss properties (those that flood repeatedly), and (3) insurance premiums would be recalculated to accurately reflect risk. BW was passed into law in June 2012 and included plans for phased rollouts starting in 2013 to gradually remove subsidies from insurance premiums. However, after Hurricane Sandy there was strong opposition to BW reforms raising flood insurance premiums. Subsequent legislation revising the NFIP removed the more significant reforms and delayed and limited premium increases (Negin 2014). Yet for residents in coastal areas affected by Sandy, flood insurance premiums have already started to increase, making rebuilding and living in these areas much less affordable and difficult for residents who are not wealthy.

6.2.2 Hazard Mitigation Grant Program and Residential Buyouts

Managed by FEMA, the Hazard Mitigation Grant Program (HMGP) is the major source of federal funding for disaster mitigation. HMGP provides grants to state and local governments to carry out long-term mitigation projects, including buyouts and land acquisition in areas that are part of a major disaster designation. The HMGP was included in the 1988 Stafford Act, which authorized the use of federal funds for mitigation post-disaster, including for acquisition of damaged properties in order to discourage rebuilding in hazardous zones and reduce risk (Rubin 2012). After major flooding of the Mississippi River in 1993, Congress updated the Stafford Act to "increase federal support for relocating flood-prone properties"[3] and clarified conditions for the purchase of damaged homes and business to require complete removal of buildings and preservation of land for recreational use or open space (Rubin 2012). After the 1993 flood, 14,000–20,000 structures were voluntarily sold through HMGP (Rubin 2012; Fazio and Strell 2013). As all property buyouts for mitigation in the United States, HMGP requires that residents voluntary agree to sell. Buyouts funded by HMGP also require participation of 100 % of property owners in the designated area and forbid redevelopment of the acquired land. HMGP can fund up to 75 % of a buyout program; the remaining 25 % can come from local government funding or recovery support funding such as Community Development Block Grants for Disaster Recovery (CDBG-DR).

6.2.3 Community Development Block Grants for Disaster Recovery (CDBG-DR)

The main source of funding for disaster recovery in the United States is Community Development Block Grants for Disaster Recovery (CDBG-DR) from the Department of Housing and Urban Development (HUD). Like other CDBG funding, used for a wide variety of community development projects, CDBG-DR funding is flexible and allocated by Congress to help cities, counties, and states recover from presidentially declared disasters (HUD Exchange 2014). The use of CDBG-DR funds is detailed in action plans that jurisdictions (usually US states) must submit and have approved, but there is significant discretion and flexibility for choosing the recovery projects included. After Hurricane Katrina and Superstorm Sandy, CDBG-DR funding has been designated for various housing recovery uses, including buyouts as one way to move people away from hazard risk areas and prevent future losses. After Sandy, CDBG-DR funds were also used to partially fund Rebuild by Design, an

[3] This update increased the amount of hazard mitigation funds available from 10 to 15 % of the total of FEMA's disaster spending and increased the federal share of funding for FEMA-approved mitigation activities from 50 to 75 % (Rubin 2012).

unprecedented disaster recovery initiative, created though the cooperation between HUD and the Rockefeller Foundation, whose projects focus on resilience and disaster mitigation.

6.2.4 The Role of Buyouts as Post-disaster Risk-Based Land Use Management

Government-funded buyouts of storm-damaged residential property played a role in land use management after both Hurricane Katrina and Superstorm Sandy. In both cases, residential buyouts were made available to selected groups of disaster-affected homeowners as one option to support household recovery, but details of specific programs vary greatly. In New Orleans after Hurricane Katrina, the Road Home Program gave owners of damaged houses the option of selling their property to the Louisiana (State) Recovery Authority (LRA) or the option of receiving a grant for house repairs. After Superstorm Sandy, selected residents are participating in various residential buyout programs in New York and New Jersey. However, a larger number of households are affected by housing elevation requirements and flood insurance rate increases related to changes in the National Flood Insurance Program (NFIP).

6.3 Land Use Management After Hurricane Katrina and Sandy

Recovery policies to support flood-devastated areas after Hurricane Katrina and Superstorm Sandy included various aspects related to land use management. The first part of this section situates land use management after Katrina and Sandy in terms of factors that influenced the formation of enacted policies and explains how these policies fit into the US historical context. The second part of this section explains how local stakeholders are involved in decision-making for projects related to land use management during recovery and how related policies influenced survivors' housing reconstruction and the built environment after disaster. Case studies from New Orleans and New York show how the ways that local governments adopted different policies for land use management influence the progress of disaster reduction and the reconstruction of housing and the built environment.

6.3.1 Hurricane Katrina in New Orleans

New Orleans is the city that experienced the most severe damage after Hurricane Katrina, which made landfall on the Gulf Coast in August 2005. Hurricane Katrina's storm surge washed over the levees and breached the floodwalls in the city of New Orleans. Water stood in over 80 % of the city for nearly 2 weeks, and 180,000 housing units were severely damaged or destroyed (HUD 2006). It took 43 days to drain the water citywide. Hurricane Katrina caused a long-term flood in New Orleans because of the city's geographic characteristics. Most of the city is below sea level, situated between Lake Pontchartrain and the Mississippi River, and was filled with water after levees on both river and lake sides failed as a result of poor construction. Built by the Army Corps of Engineers, the construction of the current levee system was started after Hurricane Betsy (1965); this levee construction made it possible to develop residential subdivisions. Campanella shows that most areas above sea level were developed in the nineteenth century or earlier, while most areas below sea level urbanized in the twentieth century (Campanella 2006). The development of wetland and swamp areas was promoted in the New Orleans area; once converted to residential and commercial uses, these areas were protected by participation in the NFIP, removing financial risk of flood damages for homeowners (Rubin 2012).

6.3.1.1 Revision of Local Zoning and Flood Maps After Katrina

Prior to the 1950s, the City of New Orleans had very loose building code regulations. It was not until after Hurricane Katrina that Louisiana adopted a statewide building code. The first form of building codes for the city, requiring slab foundations to be 12 in. (1 ft) above and pier risers to be 24 in. (2 ft) above the natural ground level, was updated during the 1950s to require foundations to be "18 inches above the highest point of the curb adjacent to the property and the lowest support beams for houses raised above ground level on piers to be 24 inches (2 feet) above the curb" (Colton 2005).

The draft Comprehensive Zoning Ordinance (CZO) and Master Plan (2030) is a City Charter-mandated planning framework for the core systems that shape New Orleans' physical, social, environmental, and economic future. The Ordinance (CZO) is the law that governs land use, and it includes lists of permitted land uses for each of the city's zoning districts, in addition to height limits, setback requirements, urban design standards, operational rules, and other regulations.

More significantly, there has not been any revision of the design standards which base the flood maps on a "100-year" flood, although much of the damage from Katrina was outside the 100-year floodplain; these design standards for the 100-year flood also do not consider subsidence and sea level rise (Rubin 2012). Koughan (2011) points out that most people assumed there would be big changes in the elevation rules after Katrina, but finally, in mid-April 2006, FEMA announced that the maps that base flood elevation regulations are based on would remain unchanged.

6.3.1.2 Land Use Management After Hurricane Katrina in New Orleans

After Katrina, neither land use control nor local zoning in New Orleans improved in terms of disaster reduction for two main reasons: the politically untenability of managed retreat and the evaluation of risk in relation to levees. In the first few months after Katrina, the mayor's Bring New Orleans Back (BNOB) planning committee released the first guidance for recovery, which included a building moratorium until FEMA updated flood maps, and a concept for clustered rebuilding known as the "green dot map," because of the green dots designating areas "expected to become parks and green spaces."[4]

Interpreting this map to mean that buildings in the green dot areas would be bulldozed and they could not come back to their homes, residents were outraged at this "greenspacing" plan (Olshansky and Johnson 2010; Seidman 2013). With many green dots on lower-income and African-American communities, and the history of disenfranchisement in New Orleans (Olshansky and Johnson 2010), residents also felt that their neighborhoods were being unjustly targeted. Opposition to the green dot map had a galvanizing effect, bringing communities together to fight for their recovery (Krupa 2010). After panic and in response to the outrage of residents, the mayor made a public commitment that all areas of New Orleans would be rebuilt and clustered rebuilding strategies were never pursued. In the context where the idea of clustered rebuilding was not politically viable, there was also no political leadership to refrain from encouraging people to move back to vulnerable areas.

The second main factor that influenced land use control policy was the understanding of flood risk in relationship to the levee system. A report by the American Society of Civil Engineers concluded that flooding in New Orleans occurred because of the failure of the levee system and its construction, meaning that land use control for disaster reduction would not be necessary if levees were rebuilt to the proper level after disaster. With this understanding, residential buyouts in New Orleans did not target any specific areas, but were available to any homeowners who wanted to sell their property instead of rebuilding. This is different from the situation after Superstorm Sandy, where some (but not all) residential buyouts are connected to land use control regulations restricting future building construction on the buyout lots.

Within the complicated recovery process of New Orleans, it is hard to know if there could have been an equitable process to encourage targeted recovery and strategic relocation of people away from higher-risk areas, but the primary obstacle was the planning process more than the regulation itself. Toward a goal of reducing risk, a plan based on the idea behind the green dot map could have been put in place through a buyout program transferring private property to public space as green landscape.

[4] The urban planners who created the original map used dotted lines and intended the circles to show areas without access to parks and green spaces, but the map was reproduced in the local newspaper with solid green dots and a caption explaining that these areas would become parks and green spaces (Olshansky and Johnson 2010).

However, the buyout program that was actually implemented in New Orleans was not for land use control but a housing damage compensation program called the Road Home Program, administered by the Louisiana State Recovery Authority (LRA). Louisiana State's goals for recovery were to rebuild housing stock and bring people back or keep them in the state. For that reason, the Road Home provided an incentive for people to stay in New Orleans or in Louisiana, by compensating homeowners with recovery support based on full-market value if they came back to the state, but only 60 % of market value if they decided to sell their home to the LRA and move elsewhere. The compensation is based on either Road Home's estimated cost of damage to the house minus other assistance received by the homeowners or the pre-storm value of the home minus other assistance, whichever is lower (Kondo 2016).

6.3.1.3 Impact of Land Use Management Decisions on Housing Reconstruction and Built Environment Transformation After Katrina

The impact of land use management decisions in New Orleans led to a "checkerboard" housing recovery, with densely populated neighborhoods coming back in bits and pieces, leaving some very sparsely populated. Homeowners did not receive any guidance about where to rebuild their houses, but they had to follow elevation requirements established based on FEMA flood maps. The Road Home Program did not implement housing buyouts on a neighborhood scale, but on an individual household basis. Even before Katrina, there was a problem of abandoned and blighted properties in New Orleans, contributing to the deterioration of public safety and falling real estate prices. This problem was compounded by abandoned vacant lots and blighted properties after Katrina, along with a lack of services such as grocery stores. The nondecreasing number of blighted and vacant properties caused deterioration of the residential built environment and difficulties for residents to return to their neighborhoods, referred to as a negative spiral for recovery (Kondo 2015).

Properties bought through the Road Home Program were transferred to the City of New Orleans, who became the owner of many single scattered lots, which were difficult to sell or redevelop. Including lots acquired through Road Home, the New Orleans Redevelopment Authority (NORA) administers three major programs to deal with vacant properties: the Lot Next Door Program, Neighborhood Stabilization Program, and public auctions.

Since 2007, NORA has been selling properties through the Lot Next Door Program, which gives owners of properties sharing a common boundary the opportunity to purchase a NORA-owned property. Intended to decrease the number of blighted properties and maintain a safe and secure built environment, this program does not encourage people to return to neighborhoods, but instead transforms the area as a low-density residential neighborhood, as many lots become yards or gardens.

The second is the Neighborhood Stabilization Program (NSP), part of a national HUD-funded program created after the foreclosure crisis in the United States to purchase and redevelop foreclosed or abandoned properties. NORA works together with 14 NSP consortium members, including housing developers and nonprofit housing developers such as community development corporations. This program has the potential to implement the "Elevate and Cluster" program proposed by the Unified New Orleans Plan to encourage residents to rebuild in clusters at higher elevations to help ensure vibrant neighborhoods and more efficient infrastructure investment in the context of a smaller overall population (City of New Orleans 2007).

This program's intended impact is not only improved safety but also (1) continuity of communities, (2) housing rebuilding and community restructuring through flood-resistant designs, and (3) restoration of community services coordinated with individual housing reconstruction. One consortium member, Broadmoor Development Corporation, uses a unique strategy that combines interventions and resources in selected zones targeted for development, including the renovation of occupied and vacant property, construction of infill development, and greening/maintenance of vacant lots (NORA 2013).

Finally, as a part of NORA's comprehensive efforts to return properties to commerce and to rebuild New Orleans' neighborhoods, NORA also hosts public auctions twice annually, at which time selected properties are sold to the highest bidder. Properties purchased at auctions require adherence to a development schedule and minimum building standards so neighbors near these properties will benefit from swift and attractive improvements.

Of NORA's three strategies, the NSP program may be able to overcome checkerboard housing recovery. In contrast to government-driven land use control, the community-based approach can be effective in the sense that community-based organizations are the most likely prospective stakeholders to have vision for holistic recovery at the community level. Stakeholders in land use management are not limited to the government level but include the community level. NORA expects community-based organizations to play the role of blighted property broker by swapping, transferring, and clustering in order to achieve their own vision to regenerate built environments destroyed by disaster.

6.3.2 Superstorm Sandy

6.3.2.1 Recovery Context After Superstorm Sandy

Superstorm Sandy struck the east coast of the United States in October 2012, causing massive housing damage in coastal states, especially New York and New Jersey. Whereas federal policies and funding for disaster mitigation and recovery such as NFIP, HMGP, and CDBG-DR are standard across different disasters in the United States, recovery policies and land use implications that have emerged in New

Orleans, New York City (NYC), New York State, and New Jersey vary in terms of respective housing recovery strategies, land use contexts, and timing of policies and implementation.

Climate Change and Rebuild by Design

Along with a stronger focus on increased resilience in recovery after Sandy, the issue of climate change has come to the fore. In New York City, which was already addressing issues of climate change, Sandy led to a larger shift in the discussion about disaster resilience and related strategies in the face of climate change, future sea level rise, and increasing predicted future mega storms. After Superstorm Sandy, strategies for disaster mitigation in New York City were developed through multiple processes and various agencies and organizations, including the Presidential Hurricane Sandy Rebuilding Task Force (chaired by the director of HUD) and the Mayor's Office of Recovery and Resiliency. Under former Mayor Bloomberg, the city released the Special Initiative for Rebuilding and Resiliency report (NYC SIRR 2013), later updated by current Mayor DiBlasio.

In addition to attempts to create buffer zones using buyout programs in some coastal areas of New York after Superstorm Sandy, the Rebuild by Design program is an unprecedented approach to planning for resilience. Created based on a suggestion from the HUD-organized Sandy Rebuilding Task Force, Rebuild by Design (RbD) used a unique combination of support from HUD and the Rockefeller Foundation. RbD included a design competition to develop multiple projects to support increased resilience at the regional level, some of which are moving forward toward implementation.

Residential Buyouts

As in the Road Home Program in New Orleans after Katrina, residential buyouts are included as one option for housing recovery support in New York City and New York State after Sandy. However, unlike New Orleans, residential buyouts in Sandy-affected areas include strategic efforts to create natural buffer zones and move residents away from flood risk areas. Using HMGP funds, some Sandy buyouts target entire areas instead of individual properties, require preservation of open space, and forbid redevelopment. Homeowners in some jurisdictions can sell to property acquisition programs, in which case the land can be resold and/or redeveloped. Current buyouts in New Jersey in river floodplains follow the established pattern of buyouts for floodplain management in the United States; since 1993 residential buyouts with HMGP have been primarily used in riverine, not coastal, areas (Smith 2012). However, larger numbers of residential buyouts in coastal areas of New York represent a new phenomenon.

Timing of NFIP Revisions and Impact on Sandy Recovery

Before Superstorm Sandy, reforms of the National Flood Insurance Program (NFIP) were already planned in attempts to address the programs' chronic budget shortfall. Homeowners may not have realized that premiums were artificially low because of government subsidies, but NFIP reforms focused on raising insurance premiums to bring them up to market rates and accurately reflect risk. Revisions of outdated FEMA flood maps also mean that more houses will be in flood zones or higher-risk flood zones, requiring higher flood insurance. The timing of Superstorm Sandy, which occurred after NFIP reforms were planned but before they were implemented, means issues of Sandy recovery and NFIP reforms have become irreversibly entangled, a deeply political issue, and a key financial factor for household recovery. Residents unable to pay the increases in flood insurance premiums will have no choice but to move away (Jorgenson 2015), and as rebuilding in these neighborhoods becomes unaffordable, neighborhood recovery will also be more difficult.

6.3.2.2 Revision of Flood Maps After Sandy

Two-thirds of houses damaged by Superstorm Sandy were outside the flood risk area designated on FIRM maps (Saul 2012). Although the area that flooded was very close to predictions for a category 1 (weakest level) storm, Sandy was downgraded to a non-hurricane level of superstorm before it hit land, so the impact of an actual or stronger hurricane would have been worse. FEMA was already in the process of revising the FIRMs for coastal New York and New Jersey before Sandy; flood maps were 25 years old, and updated FIRMS were due to be delivered to local states and municipalities in mid-2013 (FEMA 2016).

In January and February 2013, FEMA released "Advisory Base Flood Elevation (ABFE) maps," with suggested elevations for buildings in specific zones.[5] As they had been after Katrina, ABFE maps were intended as guidance for reconstruction. Although residents are not required by NFIP to comply with these "advisory" maps, following increased guidelines of ABFE maps can lower insurance rates, and it can be predicted that elevations from ABFE maps will eventually be reflected in future required FIRMs. ABFE maps for New York and New Jersey released in the early 2013 significantly increased areas in flood zones (A and V zones) that require purchase of NFIP insurance and also increased areas included in the V zone that require higher elevations and specific foundations. The revised maps nearly doubled the number of buildings in flood zones, adding 35,000 more houses and businesses (Buckley 2013). Much of coastal New Jersey was designated as V zone (higher risk) along with generally expanded flood zones (A and V zones).

[5] ABFE maps are often created after a large disaster to determine whether the 1 % annual chance flood event, shown on the effective FIRMs, adequately reflects the actual current flood hazard (FEMA Region II 2015).

However in June 2013, FEMA started releasing “Preliminary Work Maps,” an “interim product created by FEMA in the development of preliminary Flood Insurance Rate Maps (FIRMs)” (FEMA 2016) which will become the basis for final FIRMs planned to become official in 2016 or 2017. The Preliminary Work Maps showed a larger flood zone than the pre-Sandy FIRMs, but the area and number of structures included in the V zone were much smaller than the AFBEs, especially in coastal New Jersey, where the hazard level of most areas was reduced from V to A zone.

The ABFE maps had met strong opposition from local residents and government representatives, who argued that increased regulations and rebuilding costs would prevent people from rebuilding after Sandy, with the eventual result that people moving away would erode the local tax base. Vocal citizen opposition such as the “Stop FEMA Now” movement spread, fueled by the fear that unable to comply with new requirements and expenses, middle class residents would have no choice but to leave the area (Funderburk 2013). The more lenient Preliminary Work Maps were met with relief from residents and headlines such as “FEMA Flood Elevation Maps Release Helps Property Owners” (Traum 2013). FEMA stated that the maps were not altered as a result of political pressure and that the first advisory maps were based on a worst-case scenario and always intended to be adjusted. However, the perceived leniency of the newest maps raises questions whether regulations created by FEMA are strong enough to protect against another Sandy or bigger storms increasingly likely with climate change predictions. In June 2015, New York City started contesting the updated flood maps, which almost triple the number of buildings in the flood risk area, potentially affecting 400,000 people (Manley 2015). On the other hand, a report from NRDC argued that the maps actually do not go far enough to represent increasing risk from sea level rise and climate changes (NRDC 2014).

6.3.2.3 Land Use Management After Superstorm Sandy in New Jersey and New York

New York City (NYC) has a long history of established building and zoning codes, has introduced various changes to zoning codes to protect against future flooding, and has also published the “Retrofitting Buildings for Flood Risk Guide” with instructions for various housing types (Feuer 2014). To coincide with updated requirements for reconstruction after Sandy, NYC passed a text amendment to allow buildings to be rebuilt to newly established requirements (such as elevations) that would otherwise not be allowed according to height limits specified by the existing building code.

Revisions in FEMA flood maps significantly impact residential land use patterns post-Sandy though changing building regulations. However, these maps do not forbid or restrict any areas for development or inhabitation; they only specify elevation/construction requirements for buildings in respective areas. Residential buyouts, on the other hand, are initiatives attempting to relocate people from coastal risk areas and convert residential land uses to recreational uses. The impact of these programs may be limited by scope and size of implementation areas, but buyouts and property acquisition programs in New York State, New York City, and New Jersey may have various impacts on land use patterns in the region.

6.3.2.4 Buyouts and Acquisitions

In Sandy-affected areas of New York State, New York City, and New Jersey State, there are various options for homeowners to sell their property and move out of areas at risk for future flooding. Funding sources and implementation strategies differ widely, as do contexts and potential impacts on risk reduction and the recovery of local communities.

Definitions: Buyouts vs. Acquisitions in Post-Sandy Recovery

Although the meanings of “buyout” and “acquisition” are almost equivalent, these terms refer to different projects in Sandy-affected jurisdictions. In “buyouts,” land is bought for pre-storm (higher) value, and future redevelopment is forbidden. “Targeted buyouts” focus on certain defined areas, and “enhanced buyouts” provide additional bonuses to encourage participation. In property “acquisitions,” land is purchased from homeowners at post-storm (lower) value,[6] and future redevelopment is allowed. This section explains options for buyouts and acquisition in each of the three jurisdictions shown in Table 6.1.

Buyouts and Acquisitions in New York State

Under New York Governor Cuomo, former head of the Housing and Urban Development Agency (HUD), New York State made an early commitment to provide voluntary residential buyouts and convert high-risk coastal areas to natural buffer zones. Buyouts were included in NY State’s action plan for CDBG-DR recovery funding, and the NY Rising Program for housing recovery includes both “enhanced buyouts” and acquisitions. New York State’s buyout program uses some HMGP funding and follows the rules of HMGP property acquisition: redevelopment is forbidden to avoid repeated damage in the future. The areas targeted for enhanced buyouts were selected by the New York State based on risk and residents’ demonstrated interest in participating in buyout programs. Enhanced buyouts provided willing sellers with the pre-storm value of their house, plus a 10 % bonus within the enhanced buyout areas, and an additional 5 % bonus to relocate within

[6] Although it is possible to provide other types of support, such as for moving expenses, to make up the difference between pre- and post-storm property value to the homeowners, technically, the compensation for property through acquisition programs is limited to post-storm value.

Table 6.1 Residential buyout/acquisition programs in three Sandy-affected jurisdictions

Jurisdiction	New York City	New York State	New Jersey State
Role of buyouts/ acquisitions in recovery action plan (specifies use of CDBG-DR funding)	Recovery plan: Build it Back does not include buyouts, but does include a path for acquisitions	Recovery plan: New York Rising includes both buyouts and acquisitions in various areas. Eligible homeowners are those affected by tropical storms Irene, Lee and Sandy	Recovery plan: RREM originally did not include buyouts, instead includes a $10,000 bonus for homeowners who stay in NJ. However, later CDGB-DR funds used for buyouts
Buyouts	New York State program: enhanced buyouts with pre-storm value; bonus for staying in New York State		Buyouts are available through the existing Blue Acres program, not RREM
Availability	Selected for three communities in Staten Island only	In targeted coastal areas in multiple municipalities in Suffolk County	In selected communities who chose to participate (ten municipalities in six counties)
Funding	Part of New York State's enhanced buyout program, funding from CDBG-DR allocated to New York State		NJ's Blue Acres coastal land conservation program, with combined funds from HMGP (FEMA) and CDBG-DR (HUD)
Acquisition	Acquisition for redevelopment	Acquisition for redevelopment (properties sold at auction)	Not available
Availability	Available for homeowners in the Special Flood Hazard Area (SFHA) with 50 % or more damage from Sandy	Available for homeowners in the 500-year floodplain but outside of an enhanced buyout areas	
Funding	Intake through NYC's Build it Back; administered by New York State. Funds from New York State's CDBG-DR	Funds from New York State's CDBG-DR	

Sources: New Jersey Office of State (n.d), New Jersey Office of Community Affairs (2016), New York City (2013), New York City (2015), New York State Governor's Office of Storm Recovery (2013), New York State Governor's Office of Storm Recovery (2014a), New York State Governor's Office of Storm Recovery (2014b)

Fig. 6.2 Area in Lindenhurst, NJ, eligible for buyouts, such as the house in the foreground in December 2014 (*left*), already demolished in November 2015 (*right*)

Fig. 6.3 Examples of large new houses built on lots eligible for buyouts

the same county. Properties acquired will be permanently preserved as open space as part of a coastal buffer zone.

For homeowners within the 500-year flood plan but not in a designated "enhanced buyout" area, NY State's housing acquisition program compensates owners for the post-storm value of their property. Like enhanced buyouts, the acquisition program is funded by NY State's CDBG-DR grant. In May 2015, 134 of the first properties bought by NY through acquisition were sold at public auction (New York State 2015), and another auction was held in November 2015. New owners are required to demolish or repair existing housing to comply with current building regulations, including elevation requirements.

Some coastal communities in Long Island[7] include both areas that are (1) eligible for buyouts and (2) have a concentration of properties sold through the acquisition program. Among eligible properties, few have taken the buyout option (Fig. 6.2); conversely, many new large houses have been built or rebuilt on the lots that were included in the target buyout areas (Fig. 6.3).

[7] Long Island is part of New York State, east of but not part of New York City. Long Island includes Suffolk and Nassau counties, and housing acquisition is available to homeowners in both counties. However, enhanced buyouts are available to homeowners in Suffolk County but not Nassau County.

Buyouts and Acquisition for Redevelopment in New York City

In Staten Island,[8] three communities were selected to participate in the enhanced buyout program, which compensates participating homeowners at pre-storm value plus up to an additional 15 % for being in the target area and relocating within New York. Although Staten Island is part of New York City, buyouts in Staten Island are part of New York State's buyout program, funded by NY State's CDBG-DR funding. These Staten Island communities, which were heavily damaged by Sandy as well as previous storms, became the first groups in New York State to be selected for buyouts. Some houses purchased though this program have already been demolished, and tall grasses from the surrounding marsh areas have started to reclaim vacant lots. This project is discussed in more detail in the case study in Sect. 6.3.2.7.

Supported with CDBG-DR funding and depending on the level of damage, New York City's Build it Back program gives homeowners options of house repair (including elevation when required), rebuilding new houses, or "acquisition for redevelopment" for homeowners in the Special Flood Hazard Area (SFHA) with substantial (50 % or more) damage from Sandy (New York City 2016). The acquisition for redevelopment program plans to (1) acquire land, (2) carry out mitigation measures, and (3) redevelop land for residential use. The logic of this program is based the Road Home Program used in New Orleans after Hurricane Katrina and the Louisiana Land Trust set up to manage and develop properties acquired from disaster survivors at that time (Meriwether 2013). Although registration is through Build it Back, the acquisition for redevelopment program will be administered by NY State, based on a 2013 Memorandum of Understanding (MOU) between NYC and NYS; like buyout programs in Staten Island, funding for this program in NYC is also from NY State's CDBG-DR grant.

Buyouts in New Jersey Through the Sandy Blue Acres Program

New Jersey has very weak regulations for coastal preservation and past efforts to introduce coastal development controls have been unsuccessful. In fact, owners have the right to rebuild in the same place as any preexisting structure. In this context, New Jersey's action plan for CDBG-DR funds emphasized rebuilding and preserving the tax base rather than residential buyouts or the creation of coastal buffer zones. Instead, payments of $10,000 had been awarded to 18,500 eligible households as of March 2015 who promised to stay in New Jersey (New Jersey Department of Community Affairs 2016). New Jersey's Reconstruction, Rehabilitation, Elevation, and Mitigation (RREM) housing recovery program does not include any buyout or acquisition projects, but homeowners in designated areas can participate in residential buyouts through an existing HMGP-funded coastal protection program called Blue Acres.

[8] Staten Island is one of the five boroughs of New York City.

Fig. 6.4 Buyout areas in Sayerville, NJ, in December 2013, December 2014, and October 2015

Fig. 6.5 A street in Sayerville, NJ, before buyouts in December 2013 (*left*) and after demolitions in December 2014 (*right*)

Established in 1995, more than 198 properties had been purchased through the Blue Acres program before Sandy for $28.7 million, most in the Raritan and Passaic River Basins, in areas with more than $200 million of repeated flood losses (Watson 2013). New Jersey has added recovery funds from their CDBG-DR grant to this program; using New Jersey's Department of Environment Protection (DEP) Superstorm Sandy Blue Acres Program, houses in flood-prone areas can be acquired by the state for their pre-storm value, and land will be permanently preserved as public open space for recreation or conservation, serving as a natural buffer against future storms and floods. The goal of the Blue Acres program is ultimately to preserve large areas of coastal land (similar to its parent program, Green Acres, which preserves parkland); in the short term, the program's goal is to convert as much coastal land as possible to a undeveloped state, towards an outcome with both mitigation and preservation benefits. As of September 2015, 719 houses in ten municipalities in six counties had been approved for buyouts in this program, and 243 houses had already been demolished (NJ DEP 2015). These include the areas of Weber Avenue in Sayreville, NJ, shown in Figs. 6.4 and 6.5. It should be noted that these buyouts are in riverine areas of New Jersey, with no impact on land use patterns of coastal development.

6.3.2.5 Buyouts and Land Use Impacts

Potential Community Impact of Buyouts

Residential buyouts in the United States do not include measures to keep former communities together, guidance for relocation, or any support for reconstruction of new housing. Buyouts are a financial transaction, completed after the sale of property. Each homeowner therefore has individual freedom to choose where and how to rebuild, but prior community and neighborhood networks may be greatly weakened after any large buyout program. On the other hand, collective organizing can have a significant effect on the selection of a community for a buyout zone, as it did for communities in Fox Beach, Ocean Breeze, and Graham Beach on Staten Island. Buyout programs do not require the target community to initiate the project by gathering those residents willing to sell. However, limited funding for these programs and advantages for ease of administration of buyouts, as well as increased potential for creating a larger buffer zone in areas where entire communities will participate, means that implementing agencies will prioritize areas where residents are unified and actively pursuing a buyout option as a group.

Selection of Buyout Areas

Although mechanisms and implementation of buyout and acquisition programs vary between jurisdictions, all are occurring in the 100-year flood zone (or 500-year flood zone in the case of New York State acquisitions). Specific target areas were selected not only based on risk analysis but due to political, economic, and social factors. The selection of buyout areas and qualification of eligibility occur through political decisions at multiple government levels; finally, the choice to participate is a voluntary decision made at the individual household level.

The long-term aim of residential buyout programs in both New York State and New Jersey State is to relocate entire communities away from hazardous areas and create a buffer or coastal protection zone. Incentives encourage entire communities to participate, but ultimately programs are voluntary, and there is potential for a checkerboard housing recovery outcome with nonparticipating houses mixed with empty lots. This raises critical issues not only regarding disaster mitigation impacts but also outcomes for community members who are left behind—including residents who want to join the buyout but are unable to do so because of personal situations such as mortgage debt or lapsed flood insurance—and the outcome of these neighborhoods.

Analysis of Mitigation Impacts

Residential acquisitions/buyouts can benefit residents by offering them additional choices that may help individual households recover. Residents who are able to relocate to a less hazardous area benefit personally from mitigation. Buyout programs represent a very small share of recovery projects, both in terms of the number of participating homeowners and also the limited size of program areas. As a holistic overall management strategy for disaster mitigation, the role of residential buyouts is unlikely to have a significant impact at the regional scale, especially in the context of zoning policies permitting coastal development with little control. However, buyouts could be one piece of a combination of different recovery strategies that could contribute to future resilience at a community scale.

Climate Change and Sea Level Rise

Recent studies have shown that large storms the size of Sandy or larger are likely to occur regularly in the future, and as sea level rises, their impact will become more severe. Although all current recovery and mitigation measures are taking place in the shadow of climate change and these predictions, measures related to land use in Sandy recovery planning do not seem to consider this factor, especially FEMA's revised Preliminary Work Maps that reduce the number of structures and size of the area included in the most hazardous category. With increased risks predicted with climate change, potential impacts of small-scale buyout programs for future disaster resilience at a significant regional scale are even more limited. However, with the principle of residential relocation away from hazardous areas, buyouts could prove to be a first step toward improved sustainability in the region and at least demonstrate the viability of the idea of managed retreat.

6.3.2.6 NYC's Build It Back: Learning from the Road Home Program

NYC's Build it Back (BIB) program was designed with close attention to the outcome of Road Home and attempted to avoid three types of failures of that program in New Orleans: (1) poor overall management and oversight of the program itself; (2) contractor fraud—private contractors who took residents' money for repairs and then disappeared; and (3) the checkerboard land use pattern and difficulties that resulted from buyouts scattered throughout neighborhoods and the city. Build it Back was very slow to start actual implementation, partly because the program was designed to be very strict to avoid program fraud (Buettner and Chen 2014) and also due to changes in leadership of the NYC's Mayor Office and the Build it Back program itself. In terms of land use impacts, BIB's acquisition for redevelopment program was planned to avoid an outcome of checkerboard housing recovery by integrating the redevelopment of acquired parcels; because of housing and land market conditions, long-term vacant lots are unlikely in New York City. Like the buyout program, the Acquisition for Redevelopment program will be administered by New York State, not New York City, although residents apply through NYC's BIB. Although eligibility for buyouts is limited to target areas, acquisition is available to any homeowner whose primary residence is in the Special Flood Hazard Area (SFHA) and was destroyed or substantially (50 % or more) damaged.

6.3.2.7 Impact of Land Use Management Decisions on Housing Reconstruction and Transformation of the Built Environment After Sandy: Case Study of Staten Island (New York City/New York State)

The Oakwood Beach area of Staten Island became the leading community to implement New York State's "enhanced buyout program," after Sandy (silive.com 2013). On the east side of Staten Island, this community grew from a beach vacation destination 100 years ago, when beach bungalows were the main buildings. Permanent residential use developed later, and now most houses are single family or duplexes built between the 1950s and 1970s (Cheslow 1990). Tall marsh grasses called *phragmites* are a constant reminder of this area's proximity to the water. Oakwood Beach residents experienced flooding in previous storms, including Hurricane Irene in 2010 and others, and some local residents from this area lost their lives in Sandy floodwaters. These factors contributed to the strong interest of residents on or near Fox Beach Avenue in Oakwood Beach in participating in the buyout as an opportunity to sell their property and move away from an area at risk for flooding (Metropolitiques.eu 2014).

The influential role of local organizers cannot be overestimated in terms of mobilizing homeowners to participate in the buyout, attracting government support, and demonstrating residents' high levels of motivation and commitment to state officials. With the goal of moving people out of a risk area and creating a buffer zone, the enhanced buyout program targeted areas (1) that were high risk (and damaged by Sandy) and (2) where most homeowners would participate. The target communities in Staten Island fit both of these criteria, but the onus was on the community groups themselves to first demonstrate local residents' commitment in order to be selected for the program. In the end, three Staten Island communities were selected for buyouts: Oakwood Beach, Ocean Breeze, and Graham Beach.

Unlike other property acquisition programs in NYC that include redevelopment, buyouts mean that future tax revenue is lost, in this case by New York City as well as the Borough of Staten Island. This may have contributed to the fact that although several other Staten Island communities were also trying to be selected, buyout programs in Staten Island were limited to only three communities. When it was announced in April 2014 that the buyout program would not accept any more communities in Staten Island, it was explained that this was because the program would be shifting to focus on providing acquisitions for development instead (Schuerman 2014a). As of March 2015, there were 500 properties in the enhanced buyout program in New York State, including those on Staten Island as well as in Suffolk

Fig. 6.6 *Left*: These small bungalows, some of the first to be bought out in Fox Beach, are similar to many houses in the buyout areas of Staten Island in February 2013. *Right*: the same street after several houses had been demolished in December 2014

Fig. 6.7 A few houses remain next to lots where houses have been bought and demolished in Staten Island; with phragmites (grasses) coming back, these properties are quickly returning to nature in December 2014

County in Long Island, and 700 more properties in the acquisition program (Chabin 2015). The first houses in Oakwood Beach buyout (Fig. 6.6) were demolished in November 2013 (Randall 2013), and more than 40 houses in Staten Island buyout areas had been demolished by the fall of 2014 (Schuerman 2014b). By December 2014, tall grasses had already grown back to cover many of these lots (Fig. 6.7).

6.3.3 Key Differences Between Katrina and Sandy

Recovery planning after Superstorm Sandy looked to precedents of Hurricane Katrina in various ways, and some reconstruction programs dealing with land use after Sandy were designed to avoid certain issues that emerged after Katrina. Land use decisions in Sandy-affected areas of New York and New Jersey, and especially in New York City, were different from those of post-Katrina New Orleans, and respective roles of multiple levels of government were equally complex. However, post-disaster land use issues and related recovery programs and implementation processes were largely defined by the specific and respective contexts of New Orleans, New York, and New Jersey. The distinctive character of New York City, including political and financial power and attention of the nation, also shaped the scale and possibilities of recovery planning and projects in this metropolitan region.

In 2012, the discussion of climate change and future sea level rise was already widely acknowledged (NYC Mayors Office of Sustainability 2016) in New York City and the region, although New Jersey is antiprogressive in terms of acknowledging future climate impacts. Whereas the severe damage of Hurricane Katrina was known to be connected to environmental management issues such as loss of the mitigating factor of cypress swamps and wetlands, there was a much stronger and more mainstream discourse connecting the impact of Sandy and future risk of sea level rise and future stronger storms in New York in 2012. Recognition of future climate impact was therefore more integrated into the recovery discourse in New York, where there was also funding available for related initiatives.

Rebuild by Design is an unprecedented initiative that combined funding from HUD and the Rockefeller Foundation to hold a design competition for recovery projects that consider resiliency at a regional scale. The Rockefeller Foundation, which had also sponsored a planning initiative after Katrina, funded the competition portion of RbD. Some winning proposals, which include systems of levees, berms, greenways, and oyster beds/coastal reefs to mitigate the force of waves (Feuer 2014), have been incorporated into recovery projects of respective jurisdictions, with some funded with CDBG-DR and added to amended action plans. After Sandy, the role of private funding (and ability to leverage significant funds in the region), such as the NYC Mayors Fund, the Robin Hood Foundation, the Community Fund of New Jersey, and others, played a significant role in making various recovery supports available beyond projects that were specified to receive CDBG-DR funding. These more independent and flexible funds can support planning processes, as well as forward-thinking exercises that deal more broadly with issues of future resilience.

6.4 Conclusion

As in many countries, disaster recovery planning and implementation of disaster recovery projects in the US are not necessarily connected to risk-based land use planning, which is decided at the local level. After floods or other natural disasters in the United States, the federal government typically provides housing rehabilitation support or other subsidies as a compensation for property loss. Although not required by law, this has become a standard use of CDBG-DR recovery funds available from HUD. Property buyouts, such as those supported by HMGP (with FEMA funds), can be understood as an advance investment to reduce the risk of disaster. Although buyouts are helpful for homeowners who wish to leave high-risk disaster areas and relocate, the overall safety of communities is not significantly improved through residential buyouts that occur on an individual and voluntary basis.

After Hurricane Katrina, debates about land use control became negative largely because of the failure of the public planning process in regard to political issues. With past experience of inequality in planning and development patterns in New Orleans, there were strong objections to the idea of clustered recovery, perceived as continuing a long-established pattern of disenfranchisement and discrimination against poor and African-American residents and land grabs benefiting wealthy developers. The result for the recovery planning process is that there was no land use control implemented in this city at high risk of flooding. This also caused a negative impact on housing reconstruction in the form of a checkerboard housing recovery with an increasing number of blighted properties.

After Superstorm Sandy, buyouts and acquisitions of private property have given certain groups of residents the ability and opportunity to move away from areas at risk of flooding, but the impact of these actions is limited to a small part of the affected area and population, and these programs do not cover all of the highest risk areas. Without stronger regional coordination, the overall risk reduction impact of buyouts is questionable, and therefore so is the effectiveness of this investment of resources in small and scattered areas. As buyouts result in lost property tax income, their implementation is intrinsically problematic. It is difficult for local jurisdictions to choose and promote buyout programs, which implies that state-level government has to take some leadership. However, with the inherent flexibility of CDBG-DR funding for disaster recovery, which allows jurisdictions (New York City, New York State, and New Jersey) to decide their own funding priorities, the multiple programs, funding sources, and ways that buyouts are being facilitated demonstrate that there is already flexibility in existing mechanisms to carry out hazard mitigation projects.

Disaster mitigation impacts would be optimized by designating entire areas as hazardous, forbidding redevelopment, and requiring relocation. However in the United States, where all acquisitions of private property are voluntary and eminent domain is not used to acquire land for disaster mitigation, it is not possible to force all residents out of a certain area, even *if* it could be decided that this was the best (and equitable) course of action. Controls governing rebuilding in disaster-damaged areas focus instead on building elevation height (and foundation type) requirements. After Sandy, revisions to the NFIP and results of updated regulations and flood insurance premiums will likely force many residents to give up on rebuilding and move away from the shore (Khurshid 2015). But the reason is expense, not risk-based planning or land use control, and the result is that larger, more expensive houses owned by wealthier people will be built in these same areas. Acquisition programs allowing resale or redevelopment, like those in coastal communities of Long Island (New York State), may merely speed up this process.

Learning from Katrina and Sandy, it can be understood that stakeholders for land use management after a disaster need to not be limited to the government sector, but include community organizations, who can operate with viewpoints of community scale and holistic recovery. A policy shift is needed to move away from depending only on land use control, toward guidance by community-driven land use management. Land use management in post-disaster recovery is not only risk reduction countermeasures but also can guide peoples' housing reconstruction, to achieve a sustainable recovery which enables residents to rebuild their lives. Land swapping, transferring, and clustering properties to utilize blighted and vacant properties could be tools to implement land use control countermeasures.

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Chapter 7
Integrated Land Use Planning in New Zealand and Canterbury Earthquakes

Ljubica Mamula-Seadon

Abstract New Zealand is one of the first countries that introduced an integrated, sustainable management-based approach to risk management. In this environment risks from natural hazards, as well as technological risks, are managed as an integral part of land use and development planning at a local government level, in an all-hazard, consequence-based, integrated policy and planning framework. The approach requires horizontal and vertical integration across all levels of government and stakeholders. It also requires deliberative decision-making, conducted in an open and pluralistic manner, recognizing that risk appraisal involves knowledge other than technical rationality only. After over 20 years of practice, complexities of the approach had led to calls for improvements, when a series of earthquakes struck the Canterbury region in the New Zealand's South Island. The scale of the disaster prompted the central government to introduce sweeping legislative and governance changes affecting land use planning in the impacted areas. Requirements for quick recovery revealed a tension between central government obligations and the perceived need for coercion in policy making on the one hand and local capacity building and deliberation of land use planning decisions on the other. Whereas it is still early to say how successful urban and land use planning decisions will be in the long term, there are strong indications that large-scale disasters challenge decentralized planning environments, reflecting strongly on land use decisions during the early recovery period. This chapter analyzes land use changes introduced in the first 4 years of the Canterbury recovery and concludes that a better understanding of impacts a large-scale disaster might have on decentralized, integrated, and deliberative land use planning for risk reduction is necessary. This is particularly relevant bearing in mind the potential time pressures that characterize early recovery and the importance of empowerment of affected communities and deliberation of decisions.

Keywords Land use planning • Risk reduction • Recovery • Resilience • Deliberative decision-making

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7.1 Resource Management and Land Use Planning Reforms in New Zealand

New Zealand was one of the first countries to develop an integrated risk management framework based on principles of sustainable management and deliberative planning. The framework has a tiered governance system and takes an all-hazard, comprehensive approach across the four Rs of risk reduction, readiness, response, and recovery (Ericksen et al. 2003; Britton and Clark 2000; DPMC 2001; NZ Parliament 2002a). The introduction of the framework followed the radical government reforms of the 1990s designed to disempower centralized government while empowering local communities, local action and economic initiatives, as well as the local government (Memon and Gleeson 1995; Furuseth and Cocklin 1995; Buhrs and Bartlett 1997; NZ Parliament 2002b). The changes reflected a movement to allow market forces to shape local solutions and, in the natural and other hazards area, to implement the notion that risk appraisal should involve different types of rationality and knowledge and be conducted in an open and pluralistic fashion to allow for critical discourse to be an essential part of the regulatory process (Margolis 1996; Glasbergen 1998; Fischer 2003). The approach followed the trend of public participation in environmental decision-making in general that had become gradually institutionalized at federal, state, and local levels in the United States and Canada, Western Europe, Australia and New Zealand, as well as through the forums such as the United Nations and the World Bank (Innes 1997; Depoe et al. 2004; Fraser-Molekati 2012). The practice had also been influenced by demands for sustainable development and sustainable risk management (Ericksen et al. 2003; Kreimer et al. 2003).

In the sensitive area of environmental risk management the changes bore a promise that, by shifting decision-making to the local level, approaches to risk reduction can be sought that are politically more acceptable than those that can be obtained with the blunt prescriptions of higher-level coercive policies (May et al. 1996). It was also hoped that, by instilling stronger environmental ethics in policy making, local decision-makers will be more aware of the economic and environmental trade-offs they face, and appropriate decisions would have the potential for fostering environmental sustainability (ibid). Hence, the statutory framework for environmental risk management was designed to set a stage for an integrated approach, while allowing for suitable local solutions to secure sustainable management of resources. Delivery on these requirements necessitated frameworks and structures based upon a shared system of governance and policy making with integrated, comprehensive, and effect-based approaches to the management, supported by corresponding governance (Ericksen et al. 2003; Berke and Smith 2010; May et al. 1996). In practice, this required extensive coordination and cooperation among all levels of government, private sector, community groups, and other stakeholders. The degree of coordination and integration and the capacity and capability of the multitude of actors are some of the key factors that determine the effectiveness of the approach

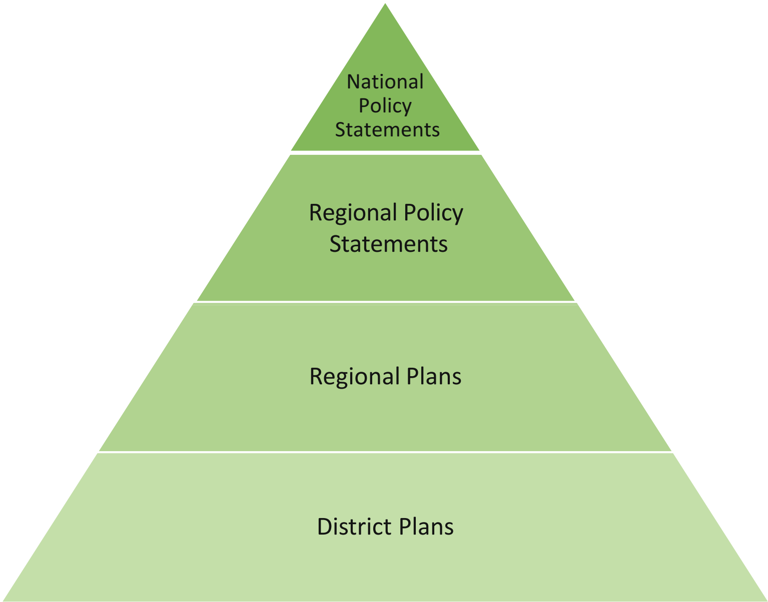

Fig. 7.1 Hierarchy of land use planning instruments under the RMA 1991

(May et al. 1996; Cousins 2002). Stakeholder input is commonly managed through rational-adaptive method in planning, with consultation at every stage of policy and plan development (Kaiser and Godschalk 1995).

7.1.1 Integrated Risk Management, Land Use Planning and Risk Reduction

Since the reforms in the 1990s, environmental risks in New Zealand have been managed as elements of environmental planning and development within the local government (regional and city or district councils). The core legislation that integrates environmental planning in the country, including land use planning for risk reduction, is the Resource Management Act (RMA) 1991 (NZ Parliament 1991). The Act provides a framework for integrating national, regional, and local level decisions about resource use and land use planning through the hierarchy of statutory planning instruments (Fig. 7.1).

The integration occurs within a framework in which the central government establishes national goals and national policy statements, regional government develops regional policy statements and plans, and territorial authorities, i.e., local city and district government, prepare district land use plans and development rules (NZ Parliament 1991). As noted earlier, the RMA follows a rational-adaptive model of planning. The key legislative instruments the RMA utilizes to bring together land use planning and resource management are national and regional policy statements and regional and district plans, as shown in Fig. 7.1. In addition, the RMA requires application for land use by anyone undertaking any development, called "resource consent application" (NZ Parliament 1991).

The functions and duties of local authorities related to land use planning for risk reduction, as specified by the RMA, include for regional councils (S. 30) "control and use of land for the purpose of the avoidance or mitigation of natural hazards" and for territorial authorities (S. 31) "control of any actual or potential effects of the use, development, or protection of land, including for the purpose of the avoidance or mitigation of natural hazards." Further to those, the Act requires that impacts of human activities—effects upon the natural and physical environment—are "avoided, remedied, and mitigated" (s. 3, s. 5, s. 17). The vehicle for achieving this in practice is a resource consent procedure. Any application for land use requires a resource consent and to follow the prescribed form to include assessment of any actual or potential effects that the activity may have on the environment, including risk from natural hazards, and the ways in which any adverse effects may be mitigated (s. 88). To ensure an integrated approach, the RMA further requires the consent authority to have regard to: any relevant regulations, any relevant national policy statement, New Zealand coastal policy statement, regional policy statement or proposed regional policy statement, any relevant district plan or proposed district plan, any relevant regional plan or proposed regional plan, as the basic reference against which "project level" application should be assessed (S. 104). The links between the RMA and other pertinent environmental risk management and land use legislation are illustrated in Fig. 7.2.

As illustrated in Fig. 7.2, besides the Resource Management Act 1991 and its suite of policy statements, regional and district plans, and the resource consent process, other key legislation pertaining to risk reduction includes the Building Act 2004 and the Civil Defence Emergency Management Act (CDEM Act) 2002. Of particular importance for land use planning was the Local Government Act (LTA) 2002 that enabled growth strategies and various land use plans that were to be strongly connected through long-term financial plans and were developed in partnership with local communities (NZ Parliament 2002b).

Enacted at the same time as the LGA 2002, the CDEM Act 2002 introduced a tiered emergency governance system (NZ Parliament 2002a). Here the central government is responsible for policy and direction setting and local capability building, with the local government responsible for implementation, and requirement for coordination permeating all levels (MCDEM 2005, 2006; DPMC 2007). The CDEM Act also required a comprehensive all-hazard, effect-based approach to emergency management, with "resilient communities" as the key national outcome (MCDEM 2005; DPMC 2007) as illustrated in Fig. 7.2. The comprehensive, integrated risk management approach comprises of risk reduction, readiness, response to, and recovery from events, recognized as the 4Rs of risk reduction, readiness, response, and recovery. These elements are not mutually exclusive but merge into each other, and each element should be fully integrated through disaster planning and manage-

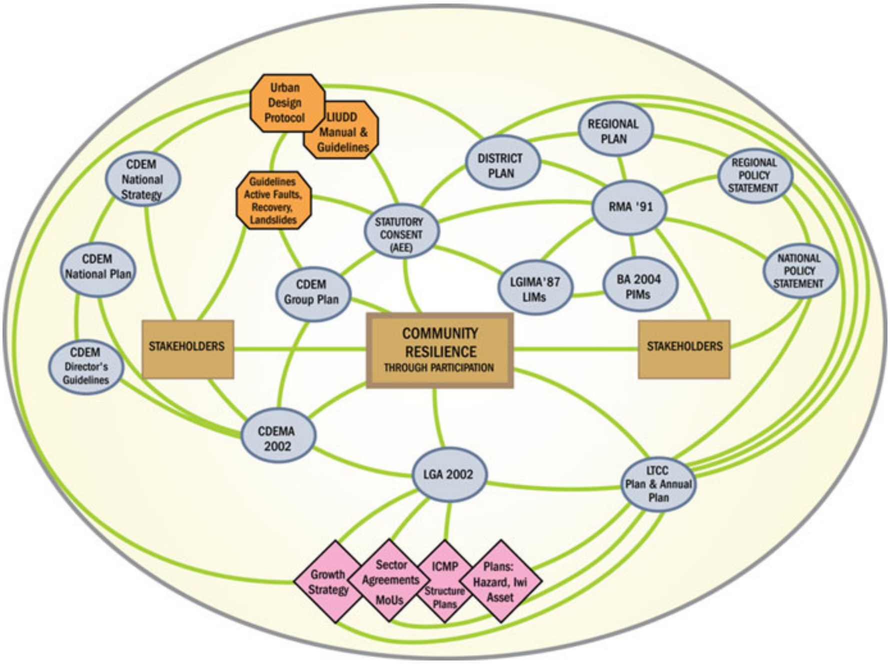

Fig. 7.2 The New Zealand integrated risk management framework (Mamula-Seadon 2009)

ment. Each element contains components of the other three and may, at least in part, be simultaneously operational. Thus, for example, the RMA 1991 contained special provisions for land use planning and consenting of new building following major emergencies (S. 330). Those RMA provisions were designed to allow for the local government to waive standard requirements under resource consent in cases when emergency or remedial works are required following an emergency.

Beyond the statutory requirements, over time a raft of non-statutory instruments had developed to support implementation of the integrated resource and environmental risk management framework. For example, under the mandate of the LGA 2002, the local government had generated a plethora of non-statutory instruments such as growth strategies, sector agreements, memoranda of understanding, strategic plans, asset management plans, structure plans and codes of practice, and integrated catchment plans, all of which have policy implications for environmental risk management and land use planning (Fig. 7.2). Councils are also required to prepare annual plans and long-term financial plans, as financial mechanisms to implement policies and plans. Most councils have also prepared strategic plans in order to set the framework within which district plans are prepared, although these are not formally required by local government legislation (Dixon et al. 1997).

At times, inquiries initiated by committees within the House of Parliament or reports of investigations undertaken by the Parliamentary Commissioner for the Environment have influenced a change in practice.

7.1.2 State of Practice Before Canterbury Earthquakes

As discussed, the New Zealand resource and risk management framework has been underpinned with a complex web of legislation and other policy instruments developed to enable integration of policy, planning, and service delivery, as well as meaningful engagement with local communities. In essence, the system was developed to operationalize the following principles of sustainable development and sustainable risk management: achievement of national goals through integrated planning, cooperation between national and local governments, regulation of effects of hazards through all-hazard approach, national efforts at building local capability, and empowered citizen participation in setting the agenda and determining decision-making outcomes (Cousins 2002). This meant that in the new environment, the expectation of all stakeholders—government agencies, businesses, and the community—needed to be refocused, with responsibility for action reallocated, therefore, requiring a consistent national approach across all sectors.

Considering its complexities, it is not surprising that the issue of risk management has proven to be often controversial, public, and highly politicized. The government has learnt that, as communities become more urbanized and their vital infrastructure systems more complex, this brings corresponding increases in vulnerability and also much higher expectations from the public. A high number of “freak” weather events and resulting natural hazards—flooding and landslips—caused major concerns about the adequacy of land use planning approaches with the risks from natural hazards induced or exacerbated by climate change. Similarly, earthquakes and tsunami events highlighted the necessity to have processes and practices in place to mitigate impacts of such events. Obviously, due to the nature of the environmental planning and risk management regime, the success of risk management activities through land use planning relied heavily on the implementation of the RMA 1991 and related policies, the application of AEE, and risk assessment practices within the local government.

Toward the end of the 1990s, critical questions about the adequacy of institutional arrangements to support the new resource management and planning regime began to emerge. Major gaps in implementation were identified, mainly pertaining to capacity and capability (Ericksen et al. 2003; Dixon et al. 1997). As a consequence, effect-based planning and the resource consent process had not always been well understood by plan makers (Ericksen et al. 2003). Furthermore, comprehensive environmental risk data to support plan-making was frequently absent or variable, while the emphasis was often placed on process and consultation at the expense of robust policy analysis (ibid). This has generated political debate, government-funded research, and a large number of initiatives to improve what was recognized as an inadequate practice. The RMA has also been challenged with regard to the Act’s social purpose and the degree of consultation required, particularly by the NZ Business Roundtable, Federated Farmers, and electoral politics (NZ Government 2009; MfE 2009; DIA 2012). Due to the fact that it was not accompanied by a robust policy framework, compared to most other legislation, the RMA relied heavily on courts and subordinate legislation for its implementation.

As a result, a comprehensive review of the RMA 1991 was conducted in 2004–2005 prompted by the need to get better and faster decisions on resource consents, to provide a means of working with councils when decisions are too big for local decision-making, and to provide more national leadership (MfE 2009). The Resource Management Amendment Act 2005 was passed in August, providing for more central government leadership, including a series of standards and policy statements to help the local government decide how competing national benefits and local costs should be balanced. At that time Section 330 allowing for waver of standard resource consent procedure for emergency and remedial works was updated.

The second generation of the RMA, LGA, and CDEM planning during 2008 and 2009 revealed a nationwide lack of integration of land use planning and risk reduction and minimal, if any, utilization of low impact urban design and other land use planning strategies that reduce risks while providing for amenity and quality of urban environment. At the same time, a more effective process for LTCCP planning was asked for, in order to incorporate community expectations and acceptable risk solutions into local land use planning (MCDEM 2009a, b).

True to its electoral promise, the National Party when elected to power in 2008 embarked on substantial reforms of the Local Government Act 2002 and further reforms of the Resource Management Act 1991. The purpose was to streamline policies, curb perceived bureaucracy, and shorten decision-making processes with the aim to enable and expedite decision-making and economic development (NZ Government 2009; MfE 2009; DIA 2012).

It is in this political climate and challenges to resource management and land use planning legislation that the devastating earthquake sequence hit Canterbury and Christchurch in 2010/2011, on New Zealand's South Island.

Before focusing on the effects Canterbury earthquakes had on land use planning, however, it might be pertinent to reflect on New Zealand's house and land insurance policy related to natural disasters.

7.1.3 *Natural Hazard Disaster Land and House Insurance and Central Government Obligations*

House owners affected by the largest New Zealand natural disaster in the twentieth century—the 1931 Napier earthquake—mostly had not been covered by insurance. This was due to the refusal of insurance companies to cover disaster damage resulting from widespread bankruptcies in the industry following the massive San Francisco earthquake of 1906. However, from 1906 general insurance companies in New Zealand had paid levies to maintain fire brigades. Following the Napier earthquake, this was utilized to propose a model to fund disaster restoration, making

New Zealand the first country in the world with a comprehensive disaster insurance for house and land (meaning the land on which the house is constructed) (Henderson 2012). By 1944, the concept had evolved to form the Earthquake and War Damage Commission (Henderson 2012).

The scope of the Earthquake and War Damage Commission's coverage extended to land and dwelling damage from flood and storm, volcanic activity, landslides and tsunami, but only for those with general property insurance who had paid the Commission's levy on top of their insurance premium (EQC 2015a). In 1993 the legislation was updated, the word "war" was omitted and the Earthquake Commission (EQC) was confirmed as the central government body replacing the Earthquake and War Commission (NZ Parliament 1993).

By the time the new legislation was introduced in 1993, the potential liabilities of EQC for the risks of catastrophe were causing serious concern, and it stopped covering commercial property, leaving the general insurance industry to take over disaster insurance of commercial property (EQC 2015a). The EQC insurance fund was initially invested mainly in New Zealand fixed interest securities, but in 2001 a part of the fund was invested in global equities, to manage risk of massive cash payouts by the government immediately following a disaster (EQC 2015a). The Commission also had a reinsurance policy in place. Until the Canterbury earthquakes in 2010 and 2011, there had not been any major claims on the Natural Disaster Fund, although hundreds of millions of dollars had been paid out on claims for smaller events (EQC 2015a). In the case of a major disaster, projections were that the Natural Disaster Fund could be exhausted in which case the Crown guarantee (i.e., central government) will have to meet ongoing claims for land and property repair (EQC 2015a).

The concerns regarding massive payout might have been exacerbated by a large number of recent disasters around the world. Those events created high expectations on central governments. Delivery on those expectations requires considerable national resources, as well as transparency and fiscal accountability. Internationally, this influenced public policy and institutional arrangements and often led to changes in preexisting frameworks (Olshansky et al. 2012). It can be argued that those large-scale disasters appeared to challenge bottom-up, integrated approaches (Suzuki and Kaneko 2013; Mamula-Seadon 2015).

Canterbury earthquakes provide an example of changes to national arrangements in New Zealand, including land use planning, in the aftermath of a major disaster.

7.2 Canterbury Earthquakes

An earthquake sequence occurring between 2010 and 2012 and originating along faults that had not been considered in city's urban planning devastated central Christchurch. During that period four large earthquake sequences with over 14,000 continuing aftershocks made life difficult for the greater Christchurch area.

The first, strong earthquake occurred on September 4, 2010, about 40 km from the Christchurch City center. This earthquake did not directly cause loss of life, but damage to buildings and infrastructure, caused mainly by widespread liquefaction of sandy soils, was substantial. The quake was followed by thousands of aftershocks, some causing further damage to the city. On February 22, 2011, a magnitude 6.3 earthquake with an epicenter only 6 km from Christchurch's central business district (CBD) and close to the surface severely impacted Christchurch City. One hundred and eighty-five people died and the government declared a state of national emergency for the first time in New Zealand history. Further severe damage was caused by liquefaction, lateral spreading, and rockfalls from steep mountain slopes. Ensuing aftershocks caused additional damage, ground failures, and building and infrastructure damage (Christchurch City Libraries 2015).

The February 22, 2011 earthquake is the largest disaster New Zealand has experienced since the early twentieth century when a powerful earthquake in 1931 destroyed Napier City on the North Island's east coast. The Canterbury earthquakes prompted the central government to introduce significant changes to the preexisting national and local risk and emergency management arrangements. Those changes, accompanied by the rezoning of areas with unstable or liquefiable soils as no-development areas, had significant repercussions for land use planning.

7.2.1 Central Government Response to Canterbury Earthquakes and Legislative Changes

7.2.1.1 September 4, 2010 Earthquake

When the earthquake hit Canterbury region on September 4, 2010, it was immediately clear that damage to buildings and infrastructure was considerable and that a major reconstruction effort was required. While the local government and emergency services were responding on the ground, the central government took urgent steps to enable and indeed expedite what was expected to be a significant recovery effort. Less than a week after the earthquake, on September 14, 2010, an Ad Hoc Cabinet Committee on Canterbury Earthquake Recovery and a new Cabinet ministerial position were established. The new minister for Canterbury Earthquake Recovery (CER minister) immediately, under the urgency provision, introduced a new legislation (Bill) to the Parliament (NZ Parliament 2010). The minister was seeking a mechanism to allow amendments to a range of legislation, with the intent to expedite recovery by removing unnecessary bureaucracy and ensuring better coordination between the central and local government (NZ Parliament 2010). An important rationale for the introduction of the new legislation was to modify legislative requirements under the Resource Management Act, particularly in respect to resource consent processes, and to streamline the Building Act (NZ Parliament 2010). The Canterbury Earthquake Response and Recovery Bill was passed unanimously and under urgency by the Parliament and became an Act. The Bill was exempt from the standard parliamentary examination processes, including the regulatory impact statement which would have provided an assessment of different options (other than the proposed legislation) and their impacts. Other standard processes that under normal circumstances allow for public and specialist input, such as the select committee hearings, were also bypassed (Mamula-Seadon and McLean 2015). The Act introduced a provision for the governor-general to use the power of Order in Council to expedite any action reasonably necessary for achievement of the purpose of the Act, upon recommendation of any of the ministers (NZ Parliament 2010, Section 1). This practically meant that the central government ministers were permitted to suspend or make exemptions to almost any New Zealand law, transferring considerable law-making power from the legislative to the executive branch of the central government.

The Act established the Canterbury Earthquake Recovery Commission (CERC), comprised of the mayors of the three impacted local authorities and four government appointees (NZ Parliament 2010). The role of CERC, besides providing recommendations on the proposed Order in Council,[1] was to address intergovernmental and cross jurisdictional coordination matters related to recovery and act as an information clearinghouse for local authorities, central government agencies, ministers, and key stakeholders (NZ National Libraries 2011). Since the legislative changes applied only to the special case of Canterbury, local authorities were still in charge of response and recovery in accordance with procedures defined by the CDEM Act 2002 (NZ Parliament 2010).

At the same time, as the appointments of the Cabinet Committee and the Minister for the Canterbury Earthquake Recovery together with legislative changes were initiated, the government started considering implications of the widespread damage to land and property in the earthquake-affected areas. This led to activities related to post-earthquake land zoning in Canterbury.

Damage survey after September 4, 2010, indicated a widespread liquefaction and lateral spreading across the broader Christchurch area. This resulted in severe damage to infrastructure—roads and utilities—as well as to residential and commercial buildings. The government commissioned a technical consultancy to provide an assessment of the impact and of suitability of land for future reconstruction, based on geotechnical information (Tonkin & Taylor 2011). The ensuing technical report zoned land into categories according to varying degrees of how much remedial action would be required, including geotechnical measures to stop the lateral spread and build the land up (Tonkin & Taylor 2011).

These central government initiatives were meant to complement a local government-led recovery (NZ Parliament 2010). To the north of Christchurch, in Waimakariri District Council, in consultation with their communities, the local council developed a recovery plan that included reconstruction and rebuilding, based on the land zone maps provided by central government. The Christchurch

[1] Orders in Council are a mechanism which permits government ministers to make changes to any law without going through the legislative parliamentary body.

City Council had effectively returned to “business as usual” operations only months after the earthquake and left much of the recovery management to the central government and CERC (Dalziel 2011; Brookie 2012). The central government was coordinating building demolitions and access control in Christchurch’s central business district (CBD), and the EQC was leading in residential building and land damage assessments (New Zealand Office of the Auditor General 2012). With CERC not having any executive power and Christchurch City Council returning to business as usual, a general perception at the time was that the recovery process was not sufficiently effective (Brookie 2012; McLean et al. 2012). This was when the most devastating earthquake in the sequence struck on February 22, 2011.

7.2.1.2 February 21, 2011 Earthquake

In the morning of the day following the quake, on February 23, 2011, the central government declared a state of national emergency for the first time in New Zealand history. The rationale for the declaration was to ensure the maximum possible coordination and cooperation between central and local resources and to demonstrate the government’s commitment to help the people in Canterbury. It was also considered that the required response would be beyond the local civil defense emergency capacity to respond on their own (Office of the Minister for Canterbury Earthquake Recovery 2011a). The central government and the Ad Hoc Cabinet Committee on Canterbury Earthquake Recovery immediately began considering new national disaster recovery governance arrangements (Office of the Minister for Canterbury Earthquake Recovery 2011a). The government proposed that a new legislation and a new central government department—the Canterbury Earthquake Recovery Authority (CERA)—be established to manage earthquake recovery for the greater Christchurch area (Office of the Minister for Canterbury Earthquake Recovery 2011b). Citing the cost of recovery and central government’s contribution to funding, as well as the need for coordination across multiple sectors and agencies, the new legislation granted vast powers to the CER minister and CERA (NZ Parliament 2011). Some of the powers that the Canterbury Earthquake Recovery Act (CER Act) 2011 granted were particularly pertinent to land use planning, allowing the minister to (New Zealand Parliament 2011):

- Obtain or require information from any person or source for any reason
- Take the land in the name of the Crown and acquire land compulsorily
- Suspend, amend, and revoke whole or any part of the RMA 1991, LGA 2002, and other Acts, as well as any plan or policies developed under various Acts and impose a moratorium on further changes or variations to plans, policies, or the Acts
- Direct any local authority to take or stop any action or make or not make a decision or perform or exercise specific responsibilities, duties, or powers

The Act also allowed the chief executive of CERA to, among other (New Zealand Parliament 2011):

- Carry out or commission works, including erection, reconstruction, demolition removal, and disposal of any building
- Subdivide, amalgamate, improve, and develop all or any land acquired by the Crown (i.e., government)
- Purchase or otherwise acquire, hold, sell, exchange, mortgage, lease, and dispose of land and personal property

The CER Act 2011 required CERA to develop a recovery strategy, as "an overarching, long-term strategy for the reconstruction, rebuilding, and recovery of greater Christchurch" (New Zealand Parliament 2011 Part 2, Subpart 3, Section 11). The recovery strategy provides the overarching vision, goals, and guiding principles for all specific plans and programs that address the Canterbury recovery (NZ Parliament 2011 S.2).

In regard to land use planning, the CER Act 2011 specifically states that no RMA document or instrument that applies to any area within greater Christchurch may be interpreted or applied in a way that is inconsistent with the recovery strategy. Provisions of the strategy prevail where there is inconsistency between it and other documents or instruments, referring in particular to the RMA (NZ Parliament 2011 S. 15).

The CER Act 2011 (S. 16) empowers the minister to direct development of recovery plans and programs under the recovery strategy. Initially it singled out a recovery plan for the CBD to be developed by the Christchurch City Council (S. 17) and to be consistent with the recovery strategy (S. 18). In relation to land use, the Act further specifies (S. 23) that any application and consequent decisions for land use (i.e., resource consent application), lodged at any time, including before the recovery plan was gazetted, must not be inconsistent with the provisions of the recovery plan. Further, the Council is required to amend RMA documents related to greater Christchurch (e.g., district plan) to include specific provisions of the CBD Recovery Plan (NZ Parliament S. 24). Other planning instruments, such as annual plans, long-term plans under the Local Government Act 2002, transport plans under the Land Transport Management Act 2003, heritage building provisions under the Conservation Act 1987, parks and reserves under the Reserves Act 1977, and the Wildlife Act 1953, must not be inconsistent with the CBD Recovery Plan (NZ Parliament 2011 S. 26). The same applied to any other potential recovery plans. Thus, the CER Act 2011 set a scene for earthquake recovery-specific planning provisions to effectively supersede any other land use planning instrument in the region (Fig. 7.3).

The Canterbury Recovery Strategy (CRS) was published in May 2012, and it further elaborated on land use planning provision for the recovery of greater Christchurch. This included requirements for supply of land for recovery needs and requirements for efficient consenting processes and a requirement to take into consideration liquefaction in land use planning (CERA 2012a, S. 5). It also required (S. 7) that, among others, government-led recovery plans and programs be consistent with the recovery strategy, particularly the goals and principles; integrate activities

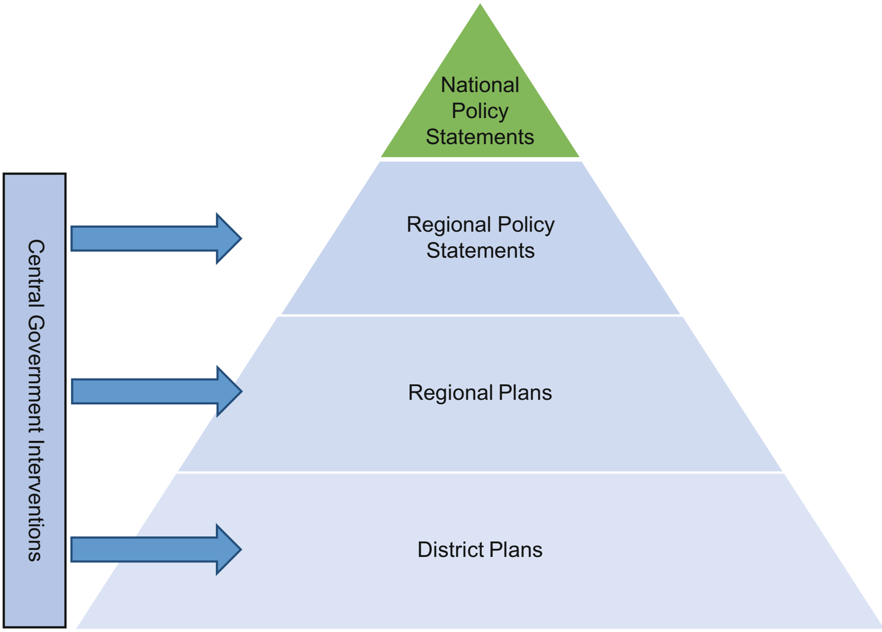

Fig. 7.3 Post-earthquake central government intervention points overriding standard land use planning processes at the local government level

to achieve multiple goals of the recovery strategy where possible; and investigate opportunities for risk reduction and enhancement to build a stronger and more resilient community and region (CERA 2012a).

It is of interest that the CRS specifies conditions for development of recovery plans when a statutory intervention is needed to undertake a particular program of work (CERA 2012a S. 7). Specifically, the strategy identified the need for a recovery plan for the CBD to be known as Central City Plan (CERA 2012a S 7.1). It also required integration of planning and recommended the use of tools, such as the Integrated Recovery Planning Guide (Christchurch City District Health Board and Christchurch City Council 2011). The last requirement effectively links recovery planning with the pre-earthquake strategic urban development planning that the Christchurch City Council and Greater Christchurch Urban Development partners finalized in 2007, not long before the earthquakes started.

7.3 Land Use Planning Matters 2011–2014

As mentioned earlier, concurrently with changes to governance arrangements following the September 4, 2010 earthquake, the government engaged an engineering consultancy to evaluate suitability of land subjected to liquefaction and lateral spreading for remedial works and reconstruction and started zoning impacted land

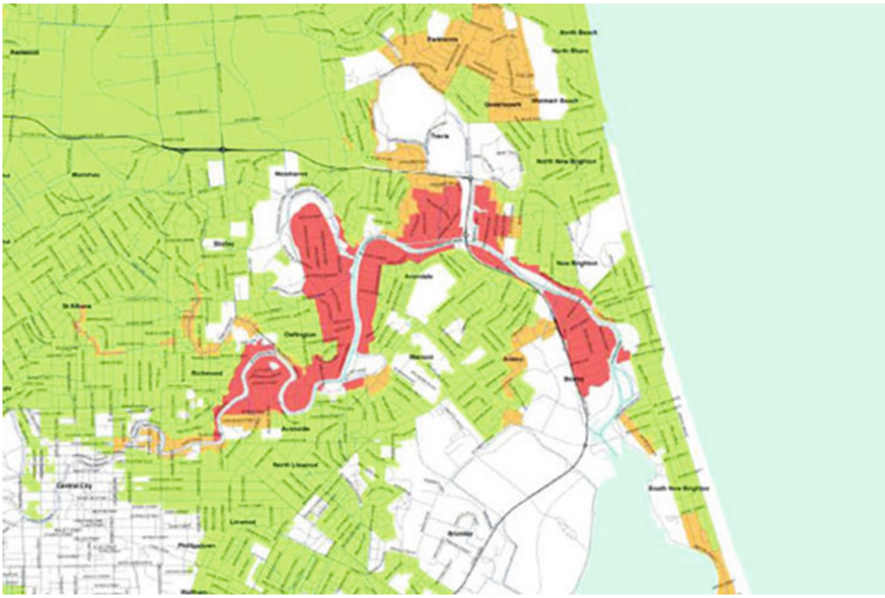

Fig. 7.4 Residential land zones in wider Christchurch, based on soil damage (RadioLive 2012)

accordingly. Following the February 22, 2011 earthquake, it appeared that any remedial works required were going to be substantive, expensive, and perhaps unattainable (Sutton 2012). Deliberations were made based on the cost of repairs, the time needed to finalize works, and any future susceptibility to damage. It was decided that the land impacted by the earthquakes would be zoned into four categories: green, good to live in; orange, undecided; white, land prone to landslides and rockfalls that needed further assessment; and red, land where land remediation and rebuilding was not considered viable (Sutton 2012; Tonkin & Taylor 2011).

Thereafter, most of urban Christchurch and some suburban areas in the east, north, and south started to be mapped into land zones (Fig. 7.4).

In June 2011, CERA released geotechnical maps with the most up-to-date information identifying residential properties that were deemed unsuitable for reconstruction as “land repair would be prolonged and uneconomic.” At the same time, the minister of CER announced a government (Crown) “buyout” program for properties in these “red zones.” With this action, CERA effectively took on a lead role in defining residential land use policy in the Canterbury region (Johnson and Mamula-Seadon 2014).

By March 2015, CERA bought 7404 properties in areas where land was deemed too damaged to rebuild on. Of the properties it purchased, 7092 were eligible for land damage payouts from the Earthquake Commission (EQC). However, further complications ensued since about 14,000 land claims were registered for increased flooding and liquefaction risk across the region caused by land changes due to Canterbury earthquakes (EQC 2015b).

The EQC has sought legal opinion and is still deciding (April 2015) what method to use to evaluate those claims. According to RadioNZ (2015), this means that so far only a portion of the money from outstanding insurance claims has been paid out and the government has recouped only $80 million of the $1.5 billion it spent buying red-zoned properties in Canterbury after the earthquakes. Research identified that the policies and procedures for land zoning and land acquisition in wider Christchurch have been both praised for providing certainty for homeowners in terms of their future and criticized as having evolved with often reactive and unclear rationale (Johnson and Mamula-Seadon 2014).

It should be noted that the central city red zone is not to be confused with the residential red zone described above. In the central city, the red zone described the area that was cordoned off after the earthquake due to widespread and substantive damage to buildings and infrastructure and the danger that posed to residents and visitors. As dangerous buildings were demolished or made safe, the size of the zone was decreasing. In February 2013, the still cordoned area was renamed the rebuild zone. Recovery of this area (CBD) is addressed in the Central Christchurch City Recovery Plan. Before discussing this plan, however, it is pertinent to mention developments leading to the introduction of the Regional Land Use Recovery Plan.

7.3.1 Regional Land Use Recovery Plan

In October 2011, the minister for CER Recovery introduced a new chapter into the Canterbury's regional policy statement, in order to accelerate the rebuilding of residential and commercial property. The chapter was founded on Proposed Change 1 to the regional policy statement, and this was being heard in the Environment Court at the time of the earthquakes. The Urban Development Strategy Partners had been working on developing a growth strategy including for prospective land use planning since 2003. Some of the region's largest landowners challenged the minister's approach in high court. In August 2012 the high court overruled the minister's interference in local planning stating that the minister had exercised authority provided by the CER Act 2011 unnecessarily and for the wrong purposes (Berry 2012). In December 2012, using the powers granted by the CER Act 2011, the minister directed the Canterbury Regional Council (Environment Canterbury) to develop a Land Use Recovery Plan for greater Christchurch, arguably with the intent to achieve the original objective of releasing land for development (CERA 2012b).

The Land Use Recovery Plan came in effect in December 2013 (ECAN 2013). As a statutory document, it directs the Christchurch City Council and the other two local councils—Waimakariri and Selwyn, as well as Canterbury Regional Council (Environment Canterbury)—to make changes to the Canterbury regional policy statement, district plans, and other instruments. Some of these changes took effect immediately and others have been developed by the relevant councils within specified time frames. The Land Use Recovery Plan covers the greater Christchurch urban area but excludes the central city area where the Christchurch Central

Recovery Plan applies, as well as the areas known as the residential red zone—these are as yet undecided. A draft plan was developed by the Environment Canterbury, in collaboration with Christchurch City and Waimakariri and Selwyn District Councils Ngāi Tahu,[2] the New Zealand Transport Agency, and with input from CERA. Workshops and public forums were held in April and May 2013 to consult on its development with the final decision on the content of the plan made by the minister of CER later in the year.

The recovery plan directs the Environment Canterbury and the local councils to make changes to RMA documents and relevant planning and policy instruments, in order to give effect to the recovery plan. The requirement not to be inconsistent with the recovery plan also applies to instruments under the Local Government Act 2002, including annual plans, long-term plans, and triennial agreements, to regional land transport strategies and programs under the Land Transport Management Act 2003 and to various conservation policies and strategies (ECAN 2013).

Specific changes to local land use planning prescribed by the Land Use Recovery Plan include matters such as changes to town boundaries (volume or footprint) and opening of new greenfield areas for development; introduction of "an enhanced development mechanism," i.e., redefinition of criteria for permitted, discretionary, or non-complying activities to speed up resource consent approval process; and rezoning of the existing development areas. It also covers redevelopment of specific existing areas, brownfield site redevelopment through changed land use patterns, intensification of existing urban areas to allow the construction of 8000–10,000 new dwellings, identification of specific town centers and hubs to be developed, and other detailed instructions for development form and function, type of housing, infrastructure, roads, parks and reserves, and other urban planning matters, normally addressed through RMA district plans and policy statements, LGA, or Transport Act (ECAN 2013 Appendices 1–4). Altogether, the Land Use Recovery Plan actions provide for an anticipated 40,000 new households in both greenfield and intensification areas. These actions support and complement the measures for the central city in the Christchurch Central Recovery Plan. The Land Use Recovery Plan also prioritizes related transport and infrastructure spending to reflect the land use planning changes (ECAN 2013).

One interesting aspect of the plan is the enhanced development mechanisms that are also utilized in the Christchurch City Plan to provide for medium-density housing, such as town houses or terrace houses, on large sites close to local businesses, open space, and public transport. This links to the community housing redevelopment mechanism that enables community and social housing that is already in place to be redeveloped and allows for higher density residential development to occur within ten geographically defined areas that already contain a high proportion of social or community housing (ECAN 2013). The intent is to apply good urban design principles and amenity requirements to ensure high-quality outcomes, with "exemplar" projects developed by Christchurch City Council, central government

[2] Ngai Tahu—the iwi or Maori tribe for the most of the South Island and Stewart Island represented by the Te Runanga o Ngai Tahu.

social housing agency Housing New Zealand, Te Runanga o Ngāi Tahu, and other housing providers, demonstrating attractive and cost-effective medium-density and affordable housing (ECAN 2013). From the effective recovery and community resilience perspective, it is interesting to observe that the contribution or partnership with affected communities is not mentioned.

From the risk reduction through land use planning perspective, the Land Use Recovery Plan requires that vulnerability to natural hazards be considered and that development is not planned in susceptible areas, including areas in the tsunami inundation zone (ECAN 2013). However, the susceptible areas and zones are not specified by the plan. This is an example that demonstrates how the speed of disaster recovery and land use planning is challenged by the necessity to consider the complex issues that have long-term ramifications for effective risk reduction and resilience building.

The Land Use Recovery Plan directed changes to the regional policy statement, district plans, and other council planning documents, even specifying the wording to be included in those documents (ECAN 2013 Appendices 2–4). As of time of writing this chapter (April 2015), the Christchurch City Council is finalizing a full review of its district plan. At the same time, the Land Use Recovery Plan is due for its first review, to assess whether it is achieving its desired outcomes. Both processes are aligned with and have a bearing on the Christchurch Central Recovery Plan.

7.3.2 Christchurch Central Recovery Plan

The CER Act 2011 assigned the task to the Christchurch City Council to develop the Christchurch Central Recovery Plan (NZ Parliament 2011). The council submitted the final draft version of the central city recovery plan to the minister of CER within 9 months of the legislation being enacted (CCC 2012). The vision, objectives, and priority projects in the plan were identified through a vast community consultation process, mainly centered around the Share an Idea and 48 Hour City Design Challenge, undertaken by the council in the period between May and July 2011 (CCC 2011). The council has been recognized internationally for the Share an Idea community public engagement campaign when a related public expo and website generated more than 106,000 ideas for the council's planning team to consider. At one point, the site was receiving nearly 1000 ideas per day. This was happening despite the fact that many people were displaced from their homes and businesses or were living in damaged homes or with no sewerage or running water (CCC 2011).

The Christchurch City Council's Central City Plan team also ran a 48 Hour Design Challenge initiative which attracted 15 national and international urban design teams who put their best plans forward for specific parts of the central city. The teams included engineers, planners, urban designers, architects and landscape architects, as well as one student on each team. Participants came from Singapore, Australia, and around New Zealand (CCC 2011). The ideas from both initiatives were brought together to help inform the draft Central City Plan, as a broadly agreed structure and direction for the central city (CCC 2011).

The resulting draft Christchurch Central Recovery Plan was to be funded through the council's long-term plan (LTP). The cost was estimated to reach almost $2 billion NZD. The council presented the plan to the minister for CER for approval. The minister reviewed the draft plan and, taking into account its impact, effect, and funding implications came to the view that there was insufficient information in the draft on how the recovery plan would be implemented and that the proposed changes to the district plan needed to affect its implementation were unnecessarily complex (CCC 2012). Instead of approving the plan, the minister made a decision to establish a special unit within CERA, the Christchurch Central Development Unit (CCDU), and tasked it with re-developing the Christchurch Central Recovery Plan and leading its implementation, working in close collaboration with the council, Te Runanga o Ngāi Tahu, and other key stakeholders (CCC 2012).

The creation of CCDU effectively terminated Christchurch City's responsibility for recovery planning (Johnson and Mamula-Seadon 2014). CCDU engaged a consulting team and developed a new Christchurch Central Recovery Plan in 2 months (CCDU 2012). Pursuant to Section 24 of the CER Act 2011, the newly developed Christchurch Central Recovery Plan directed the inclusion and removal of specific objectives, policies, rules, and other methods in Christchurch City Council's District Plan, to be made by the Christchurch City Council as soon as practicable (CCDU 2012, Appendix 1).

The Christchurch Central Recovery Plan sets out the vision for the city by defining the form of the central city (the core and the outer areas—the frames) and setting out locations of anchor projects that were to encourage investment and growth (CCDU 2012). The stated intent of the plan was to create a distinctive, vibrant, and prosperous central city that encourages people to reinvest in it, economically and emotionally (CCDU 2012). To enable that, the recovery plan directs amendments to the Christchurch City District Plan, such as changes in zoning to help consolidate the core, changes to permitted activities within different zones, the need for streamlining consenting processes, and other urban design matters (CCDU 2012).

Seventeen "anchor projects" were identified to replace key civic and community facilities. The plan states this is to stimulate additional development, attract people, and regenerate and improve the urban form of the city. They were selected to inspire confidence and give momentum to the inner city rebuild (CCDU 2012).

A spatial framework is provided by the blueprint plan, showing the new central city layout and the locations of anchor projects (Fig. 7.5).

As depicted in Fig. 7.5, the blueprint for the rebuilt city center aims to provide for a prosperous, accessible, and vibrant city that remembers and welcomes.

The original CC recovery plan was followed by a release of an accessible city plan in 2013 that outlines a transport system that will support recovery of the central city and provide for easy access to facilities and public spaces (CCDU 2013).

A liveable city plan was announced in July 2014 and became operative in January 2015. This is a residential chapter of the CC recovery plan that contains a vision and

CHAPTER	PROJECT
A City that Remembers and Welcomes	1 The Earthquake Memorial 2 Te Puna Ahurea Cultural Centre
A Green City	3 The East Frame: a new inner city community 4 The Frame 5 Te Papa Ōtākaro/Avon River Precinct 6 The Square
A Prosperous City	7 Retail Precinct 8 Government Accommodation 9 Convention Centre Precinct 10 Health Precinct 11 Justice and Emergency Services Precinct 12 Innovation Precinct
A Vibrant City	13 Performing Arts Precinct 14 Central Library 15 Residential Demonstration Project 16 Metro Sports Facility 17 The Stadium 18 Cricket Oval
An Accessible City	19 Bus Interchange

Fig. 7.5 Central Christchurch recovery plan anchor projects (CCDU 2012)

objectives for central city living. Importantly, the liveable city plan includes several initiatives to stimulate development of housing and communities, one being a rebate for residential development in the central city, providing development meets certain criteria. Those criteria include adding at least one more residential unit to what previously existed on the site and meeting good design requirements. The rebate fund is capped at $10 million, and the scheme will end on June 30, 2016, by which date developments must be under construction (CCDU 2015). The central government is also providing development contributions in the frame areas of the CC recovery plan.

For example, in the New East Frame neighborhood, the government is establishing a new central park; building cycleways, walking paths, areas for community gardens, and family playgrounds; and preparing land for sale to private developers (CCDU 2015).

7.3.3 Land Acquisitions, Christchurch District Plan, and Other Land Use Planning Matters

Areas designated as a site for one of the anchor projects were subject to restrictions on use and most of them have been acquired by the Crown (government). Thus, under Section 54 of the Canterbury Earthquake Recovery Act 2011, the minister of earthquake recovery acquired land for the implementation of the Christchurch Central Recovery Plan, having publicly informed of his decision. The land included areas where anchor projects are, but also areas in the frames (CERA 2012b).

As directed by the Central Christchurch recovery plan and the regional Land Use Recovery Plan, and under the provisions of the CER Act 2011, the Christchurch City Council undertook a review of its main land use planning instrument—the district plan. In the process, the council amalgamated two hitherto separate planning documents—the Christchurch City District Plan and the Banks Peninsula District Plan into one, the Christchurch Replacement District Plan (Banks Peninsula experienced severe landslips on coastal bluffs and massive rockfalls from the adjacent hills).

Among other planning matters, the proposed Christchurch Replacement District Plan addresses natural and other hazard risk reduction measures. This includes climate change-induced risks as well. The proposed plan requires that risk reduction be integrated in planning decisions and specific flooding, liquefaction, cliff collapse, rockfall and other mass movements, tsunami, storm surge, coastal erosion, and risks exacerbated due to climate change and/or multiple hazards addressed. The plan specifies risk avoidance by not granting land use consents for new development (subdivision and urban zoning) in areas where there is "intolerable risk of loss of life or serious injury" or where there is a potential for serious event and the risk "cannot be mitigated to an acceptable level" (CCC 2015 S. 5.2.1). The proposed plan further requires restriction of land use to avoid or mitigate hazards in general, precautionary approach in cases where there is no clarity on hazard, as well as restriction on any land use that worsens, adds, or transfers hazards. The plan also requires protection of natural landscape features that enhance resilience to hazards and raise awareness about hazards with property owners (CCC 2015 S.5.2). The plan then specifies measures to be implemented in land use planning in areas prone to flooding (such as avoidance, protection works, rising floor levels), geotechnical hazards (such as avoidance and adequate risk assessment), and slope instability (such as avoidance, including avoidance of mitigation works in areas susceptible to large-scale mass movement (CCC 2015 S.5).

At the time of writing this paper (April 2015), submissions to the proposed district plan have closed. However, the plan has not been made operational and has been criticized by both the central government and independent bodies. Furthermore, it is interesting to note the accents on hazard mitigation, rather than risk mitigation in the plan, as well as the stress on avoidance of hazard. Whereas ambitious in its requirements to avoid and mitigate hazards, the risks from those hazards are not quite clear; other solutions perhaps not sufficiently explored and a lot left for interpretation. Thus, the district plan leaves a lot to be worked out through implementation and testing in courts and, hence, has the potential to dramatically slow resource consenting processes. Perhaps that is why the reaction to the proposed Christchurch Replacement District Plan drew comments such as "too much red tape in planning rules." Both the Minister for the Environment and the Minister for CE Recovery commented that the proposed new planning rules for Christchurch are confusing and bogged down by too much red tape, with "competing, confusing and conflicting provisions" (Stuff 2015). The ministers' letter was accompanied by a lengthy report that included 93 recommendations for change (Scoop 2015). The criticism echoes that made by the independent hearings panel, chaired by a high court judge, who criticized the CDRP's Strategic Directions chapter for being "wordy and vague and in many respects ineffective" (Scoop 2015).

7.4 Canterbury Recovery: Implications for Land Use Planning and Risk Reduction

New Zealand integrated policy and planning framework in place before the Canterbury earthquakes provided for risk reduction and resilience building through a whole-of-government, effect-based natural, and other hazard risk management. The approach centered on the role and leadership by the local government, with the central government setting a direction and providing support and capability building. The framework had been in place for almost 20 years when the earthquake sequence commenced. In this framework, the key mechanism for risk reduction was land use planning, as a part of a broader sustainable development agenda, managed at the local government level. Governance model supporting the framework was intended to enable local initiative, integration of government and civil action, and deliberative planning.

The principles the New Zealand framework was based upon stressed the interdependency between social, economic, natural, and built environment, addressed through integrated planning and building of the community's adaptive capacity, i.e., strong social capital resting on competent communities empowered by civic agencies. It can be said that the earthquakes, therefore, afforded an opportunity to implement the approach that, theoretically, had all characteristics of the systems designed to ensure effective community-based recovery and long-term resilience.

As discussed earlier in the paper, the weaknesses in implementation of the pre-earthquake framework had been known. They did not necessarily pertain to the fundamentals or principles, but mainly to capacity and capability for implementation and excessive bureaucratization and legalization, probably stemming from issues with capacity and capability. Even before the earthquake sequence started in September 2010, the government had embarked on reforming the legislative framework, particularly the Resource Management Act 1991 and the Local Government Act 2002, the two legislative instruments governing land use planning in the country. The declared purpose of those reforms was to address shortcomings of the existing framework, in order to streamline policies, curb perceived bureaucracy, and shorten decision-making processes, with the aim to enable and expedite decision-making and economic development.

Notably, at the time the earthquake sequence started, local governance was in turmoil in the Canterbury region, mainly over resource management issues, with the central government appointed commissioners responsible for the regional council (Environment Canterbury). This was seen as reflecting specific politics and tensions within the region, as well as a general weakness of the tiered governance system and the breakdown in relationship between territorial authorities and regional councils.

In response to Canterbury earthquakes, central government introduced substantive changes to recovery legislation and governance arrangements. These changes reflected on land use planning as well as many other areas of risk management, policy, and planning. Over a period of couple of years, a hitherto decentralized regime saw progressive increase in centralization of power. When analyzing implications of changes to recovery arrangements immediately following the February 22, 2011 earthquake, Johnson and Mamula-Seadon (2014) identified that the governance structures for managing recovery following the Canterbury earthquakes have transformed significantly, at both the national and local levels, in comparison to preexisting arrangements. While the centralization that occurred may have helped to strengthen coordination among national agencies and expedite policy and decision-making at the national level, the effect it had on local governance and local communities requires better understanding (Johnson and Mamula-Seadon 2014). The issue of public engagement and deliberation of key planning decisions appeared to be an area where the newly introduced governance transformations may not have been as effective (Johnson and Mamula-Seadon 2014).

In regard to land use planning, an early move by the central government to base its land zoning decisions, and indeed to opt for land zoning informed by technical investigation, warrants thorough consideration. This represents a significant departure from the planning approach that for a considerable time avoided zoning and technical rationality-based decision-making in planning and centered on collaborative planning and decisions made on collective choices, where technical information was only one of the factors. Implications of this precedent have to be understood and carefully monitored, especially bearing in mind that changes to the main legislation governing land use planning—the RMA—are currently high on the government's agenda. Besides the matter of zoning, the central government led decision-making on suitability of land for development presents a significant precedent the implications of which have yet to be tested in the future.

Considering that the central government underwrites disaster land and house insurance and the perceived risks of EQC running out of funds to settle all claims by affected owners, it is understandable that the government and EQC were keen on understanding the implications of ground condition-induced damage. EQC started drawing on the disaster fund immediately after the September 2010 earthquake. In the process of meeting claims, the fund's global equities were entirely liquidated by May 2012, and a portion of the government stockholdings was also sold (EQC 2015a). Since then, the fund has been made up of only New Zealand government stock and bank securities with current projections that Canterbury claims will eventually exhaust the Natural Disaster Fund. If this occurs, the Crown (government) guarantee will meet ongoing claims, as will be the case if another disaster occurs in the near future (EQC 2015a).

As the recovery process unfolded, the central government progressively took over land use planning and, indeed, dictated most of the decisions. Undoubtedly, a bold and visionary plan for the future city was offered. Attention was paid to good urban design and requirements for risk reduction were incorporated into planning documents.

However, those same decisions and solutions that were hailed for their expediency and quality of design have been criticized for the lack of community involvement in deliberation. In addition, the process for establishing the CCDU, for example, has been criticized for its interference into a local authority-led initiative and for the soundness of the very short tendering process (Oram 2012; Sounders et al. 2014). The unit has also been criticized for beginning to accept development applications without having established clear criteria for screening and selecting among competing applications (Sounders et al. 2014).

Another criticism directed at the central government uses the fact that, 4 years after the quake, only 10 % of the planned rebuild was completed, and out of 19 major projects, 14 will not be completed on time (Bennett 2014a). This raises questions about effectiveness of the central government intervention in terms of fast recovery in general and not only in terms of deliberation with local communities.

Perhaps the most poignant criticism relates to exclusion of public from decision-making, detrimental both to the future livability of the city and to the effective recovery and resilience building. The lack of meaningful engagement with local communities has been persistently criticized (Dalziel 2011; Johnson and Mamula-Seadon 2014; Bennett 2014a, b; Mamula-Seadon and McLean 2015).

Furthermore, an overarching goal of the New Zealand emergency management framework is community resilience. This includes building community resilience through recovery. In the recent literature, community resilience emphasizes adaptation and strengthening of community bonds. These traits are demonstrated by the community's competence and society's ability to be self-organizing and capable of learning, innovation, and creativity. The conditions that most effectively integrate the individual, community, and institutional factors that develop societal adaptive capacity involve competent and empowered individuals and communities and high levels of trust and engagement between them and civic agencies. This requires an institutional context that promotes empowerment and sharing knowledge (Seadon and Bach 2015). Self-mobilization of Christchurch communities, their energy and innovation following the September 2010 and February 2011 earthquakes are well documented (Seadon and Bach 2015). Yet that energy does not seem to have been harvested in the early recovery (Mamula-Seadon and McLean 2015).

Analyzing transformation of governance following the two main shocks in September 2010 and February 2011, in relation to societal resilience and building of social capital, Mamula-Seadon and McLean (2015) conclude that the issue of control of very high impact disasters—whether it should be "forward" at the site of the event or centrally by the government—does not yet seem to have been addressed. Partnering with communities in recovery decision-making, taking on board community-led action, and sustaining and building on the initial momentum that Christchurch communities so generously created seemed to have fallen victim to the perceived need for "quick recovery" (Mamula-Seadon and McLean 2015). Those same characteristics apply to land use planning decisions.

The original legislation, more than 20 years ago, intended land use planning as an element of integrated risk management, to provide effective solutions that will bring together good urban planning and community empowerment, as well as liberate economic initiatives and development at a local level. Whereas there have been many achievements in Christchurch recovery, meaningful engagement, and, indeed, partnership with broader local communities, creation of locally preferred opportunities and solutions seems to have not been as robust as desired. Implications of the direction recovery has taken in Christchurch are as yet too early to evaluate. Land use decisions, the form and function of the future city, and the effectiveness of risk reduction measures in terms of long-term urban resilience, including community resilience and good urban design, will be subject to scrutiny for many years to come. At this stage, it is only certain that precedents have been created, such as emphasis on technical rationality-based decision-making, strong central government involvement and setting of planning parameters, avoidance of risks, and zoning, to name a few. Those precedents and their impact on future legislation, policy, and practice require careful monitoring. This is even more pertinent bearing in mind that the legislation governing land use planning in the country—the Resource Management Act—is currently under review. Also, a transition of powers from CERA to CCC has commenced, with CERA, or most of its departments, set to close in 2016.

7.4.1 Large-Scale Disasters and Integrated Land Use Planning

Large-scale disasters appear to challenge integrated, bottom-up approaches and often result in changes to preexisting arrangements. Thus, disasters may act as a catalyst for accelerated change to legislation and practice that can be both beneficial or can set back the practice. Transformations in legislation and policy following

Canterbury earthquakes occurred against a backdrop of an already initiated change to the integrated risk management and land use planning framework in the country.

It is still far too early to evaluate implications of those changes for the future form and function of the city and its liveability. The same applies to understanding of impact of numerous precedents in land use planning that were created. Developments in Christchurch will doubtless have a broader impact nationally. There are clear indications that monitoring future developments and understanding implications of modifications to land use planning practice Canterbury earthquakes triggered warrants attention.

The New Zealand Parliament has recently initiated an inquiry into disaster management frameworks and policy, with the view of developing legislative guidelines governing central government interventions in situations of large-scale emergencies. Without doubt, the inquiry will bring into the focus the question of central control versus local empowerment, including in land use planning matters. Considering a relatively long history of decentralized, integrated, and deliberative planning-based land use and risk management practice, the outcome of this process requires close attention.

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Chapter 8
The Rapid Development of Settlements in Flood-Prone Areas in Peri-Urban Ulaanbaatar, Mongolia: Monitoring and Spatial Analysis Using VHR Satellite Imageries

Izuru Saizen and Narumasa Tsutsumida

Abstract Mongolia is a mostly arid or semiarid country, so it might seem strange that floods could be one of the disaster threats it faces. However, the low precipitation and high evaporation of surface water are a result of the low absorptive capacity of the soil, and, accordingly, higher than normal precipitation often results in run-offs, which have the potential to become flash floods. In a peripheral area of Ulaanbaatar, the capital municipality of Mongolia, residential areas called *ger areas* have expanded rapidly in an unplanned manner because of the poor execution of land reform policy, and considerable migration has resulted from a natural hazard—*dzud*. These areas have been encroaching on flash-flood-prone areas, which have resulted in a dozen people losing their lives in 2009. This chapter introduces the background of *ger* areas expansion and reveals the actual situation of their spatial distribution over flash-flood-prone areas using VHR satellite imageries.

Keywords Ulaanbaatar • Urban sprawl • VHR satellite imageries • Flash flood

8.1 Introduction

During the last 15 years, the growth of urbanization in Mongolia has been rapidly accelerated, and the increase in population numbers in Ulaanbaatar, which has over 1.15 million people, had reached approximately 40 % of the total Mongolian population of 2.75 million in 2010 (Huang et al. 2013). In a peripheral area of Ulaanbaatar, residential areas called *ger areas* have developed rapidly in an unplanned manner owing to a land reform policy enacted in 2003, which allows Mongolians to have free private land for residential purposes. Many of the residents of *ger* areas did not

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register as citizens because of the lack of registration of land so when they migrated to Ulaanbaatar from other provinces, such immigrants were not reflected in the statistics compiled by the central government (Toshiki et al. 2015). The dramatic transition of Mongolia from a planned economy within the former Soviet-backed state socialist system to an independent state with a free market economy in 1992 has also led to the concentration of the population (Sneath 2003). Mongolians were freed from restrictions on internal migration and occupational choice. Consequently, urban areas absorbed many rural Mongolians who sought opportunities for jobs, education, and public services (Kamata et al. 2010). Minimally, an estimated 81,600 households lived in a *ger* area in Ulaanbaatar in 2012 (Huang et al. 2013).

Ulaanbaatar is located in a valley along the Tuul River, which penetrates Ulaanbaatar. The *ger* area has been encroaching toward the hillside of this valley resulting in a high risk of flash floods. Owing to the uncontrolled expansion of *ger* areas because of the increase of migrants, a dozen people were killed by a severe flash flood in 2009. This chapter points out the spatial expansion of *ger* areas and subsequent development of houses that are not reflected in official statistics of such areas, by spatial analysis using very high resolution (VHR) satellite imageries.

8.2 Climate and Natural Hazards in Ulaanbaatar

8.2.1 Climate in Ulaanbaatar

An extreme continental climate in Mongolia, the nineteenth largest country in the world, generates cold, harsh, and long winters. The annual average temperature is less than 0 °C, and the capital Ulaanbaatar, the biggest city of the nation, is the coldest capital in the world (Chung and Chon 2014). Monthly average temperatures are around −20 °C during the winter season, and nighttime temperatures can go down to around −40 °C. Precipitation is limited mostly to the short summer period; moreover, the annual rainfall is only about 200–220 mm, while the winter season is extremely dry (Saizen et al. 2010; Worldbank 2009).

8.2.2 Natural Hazards Associated with the Population Concentration in Ulaanbaatar

Although previous studies concerning natural hazards in the world have focused attention on physical environments, such as coasts (Dewan 2014; Singh-Peterson et al. 2014), mountains (Liu et al. 2011; Manandhar et al. 2015), and small islands (Adrianto and Matsuda 2002; Hiwasaki et al. 2014), synthetic hazard research specifically focused on dry lands is not common (Middleton and Sternberg 2013). Research of particular types of hazard in dry lands, however, can be found, such as geomorphological hazards (Marren 2005) or particular combinations of dryland hazards (Middleton and Sternberg 2013).

In the Mongolian case as well, only particular types of natural hazard named *dzud* had been the primary focus in the relevant academic fields (Fernandez-Gimenez et al. 2015; Tachiiri et al. 2008). A severe hazard in the mid-latitude and high-plateau dry lands of Central Asia known as *dzud* occurs when extreme winter cold, snow, and ice render forage inaccessible or unavailable, resulting in high livestock mortality. However, at least five types of *dzud* are identified by Mongolians according to the combination of climate anomalies (Begzsuren et al. 2004). The most common type is the white *dzud*, the complex of deep snow and drought. When such heavy snowfall is preceded by drought in the previous summer, resulting in poor forage conditions, livestock mortality is often particularly high among animals, which do not gain sufficient weight during the summer to survive the severe winter. Some of the most severe white *dzuds* in Mongolia in recent decades occurred between 1999 and 2002 and in 2010. The *dzud* between 1999 and 2002, which was accompanied by a lack of precipitation during the spring and summer, had disastrous results for Mongolian livestock, with 12 million animals dying on a nationwide basis. Of an estimated 190 thousand herding households, 11,000 households lost all their livestock (Saizen et al. 2010). As a result, many of these herders were forced to quit their nomadic herding and migrate to Ulaanbaatar to find new job opportunities. It seems reasonable to suppose that the *dzud* disasters occurring in recent decades were an indirect cause of population increase in Ulaanbaatar, which exacerbated the living environment in *ger* areas.

8.2.3 Flash-Flood Damages in Ulaanbaatar

As mentioned above, Mongolia is a mostly arid country where it would be widely unknown that flood was one of the relevant disaster threats. The low precipitation and high evaporation of surface water result in low absorptive capacity of the soil, and, accordingly, higher than normal precipitation often turns into runoff with the potential to become flash floods.

A flash flood is an extreme rainfall event causing rapid runoff from sparsely vegetated slopes on an occasional basis (Middleton and Sternberg 2013). They are often accompanied by other phenomena such as landslides and mudflows and can cause bridge collapses, damage to buildings, and fatalities. Although Jonkman (2005) pointed out that mortality by flash floods in the world is higher than any other form of flooding in terms of the number of fatalities divided by the number of affected persons, it is a poorly understood hazard in dry lands (Foody et al. 2004). Similar to other cities in dry lands, flash floods in Ulaanbaatar have been occurring, and they affect residents every year. The high-risk potential of flash floods is related to their rapid occurrence and typically localized nature; hence both factors leave very limited opportunities for an effective response. Accordingly, the most effective, easiest, and best strategy to reduce their risk potential is to avoid the development of residential areas and other facilities in flash-flood-prone areas.

JICA (2002) reported that flash-flood-prone areas in the *ger* areas mostly correspond with the areas near rivers and, topographically, on steep slopes. According to the land privatization law in the land reform policy, privatizing lands near water is not allowed for Mongolian citizens, but damage to their houses and properties by flash floods has often been reported (UN-Habitat 2010a). The execution of land privatization laws would fail in terms of urban management as it is difficult to confirm the spatial distribution of settlements in *ger* areas because of illegal house construction. Given the nature of flash floods, understanding such distribution is important and should be elaborated in detail for proper management of living conditions and future disasters.

8.3 Study Area: The Rapid Development of Settlements in *Ger* Areas

8.3.1 Study Area

We chose a study area with an area of approximately 33 km^2 (Fig. 8.1) located in the western part of the peripheral area of Ulaanbaatar, in which *ger* areas had experienced extreme expansion throughout the last decade. Enkhtaivan Avenue, one of the main roads in Ulaanbaatar, is oriented east to west along the southern edge of the study area. The area on the south side of the road is part of the city center and includes some apartments and commercial facilities as well as other land use types—factories, schools, and governmental facilities. *Ger* areas are primarily spreading on the flatlands and hillsides located on the north side of Enkhtaivan Avenue.

8.3.2 Developments of Ger *Areas*

Rural Mongolians, and especially nomadic people, typically live in a *ger*, which is a traditional nomadic tent designed for a nomadic lifestyle in grassland; it is a circular tent-like structure consisting of a wooden framework covered with felt. As it is mobile, lightweight, and portable, and therefore well suited for easy movement, the *ger* is an ideal living solution for nomadic people and well adapted to sustainable nomadic life (Kamata et al. 2010; Mocellin and Foggin 2008).

Taking advantage of its portability, many migrants relocate to the city or peripheral areas. Migrants declare a right of land possession; build wooden fences named *khashaas*, which mark their property boundaries; and build a *ger* or a detached house on the enclosed land with or without registering the privatization of the land (Kamata et al. 2010). In this way, *ger* areas, which are typically composed of both formal and informal residential plots, have been created (Fig. 8.2). Once they

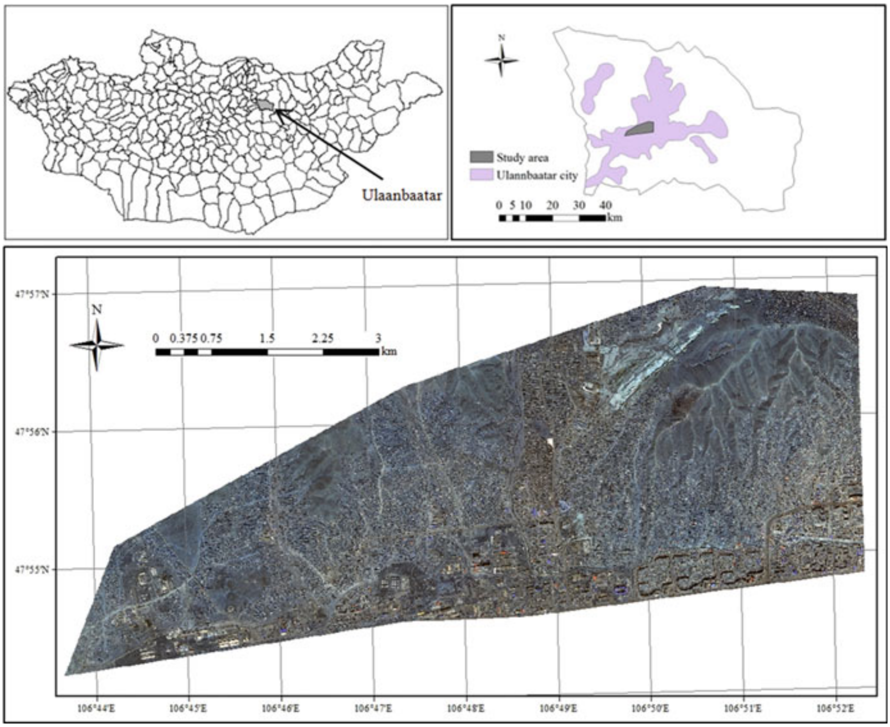

Fig. 8.1 The map of study area showing QuickBird imagery taken in 2008

Fig. 8.2 Landscape of the *ger* area (Photo by Saizen in August 2011)

occupy their own land, their houses seldom if ever move again thereby losing the function of portability. As a result of these practices, about 60 % of the population of Ulaanbaatar lives in *ger* areas (Kamata et al. 2010; UN-Habitat 2010b).

8.3.3 The Degradation Living Environments Caused by **Ger** *Areas*

It was widely reported that the expansion of *ger* areas on the peripheral areas of Ulaanbaatar has a negative impact on the natural environment and living conditions of both *ger* areas themselves and city centers (UN-Habitat 2010b). For example, air pollution caused by the emissions from household stoves in winter is one of the critical environmental problems. On average, a *ger* in an urban area consumes a staggering 5 tons of coal and 1.5 tons of wood fuel per year or more than 20 kg of coal per day during the winter season (Sovacool et al. 2011). In addition, the basic infrastructure, such as piped water systems, sanitation facilities, paved roads, public transportation, and heating systems, is not well developed. Social and spatial inequality, water supply and sanitation, waste management, and air pollution have become urgent issues. International donor-funded projects are addressing such issues by assisting with the development of much needed infrastructure (Tsutsumida et al. 2015; UN-Habitat 2010a). In particular, water kiosks, based on funding from international donors, are being constructed to satisfy the basic human need for water because the houses in *ger* areas are not connected to the public water supply system (Tsutsumida et al. 2015). Construction of these water kiosks, however, may encourage disorderly expansion of *ger* areas in some respects because they contribute essential water supplies to all of the residents. Therefore, the lack of basic infrastructure can be considered one of the factors that degrade living environments and induce the chaotic formation of *ger* areas.

8.4 Residential Developments in Flash-Flood-Prone Areas

The flow of data processing and construction is shown in Fig. 8.3 We constructed the GIS database on the exact location of the *gers* from VHR satellite imageries to explore the spatial distribution of settlements in flash-flood-prone areas from a topographical perspective. Note that all of the *gers* are not used for settlement, meaning that some residents possess several *gers* to use for storage; however, it is quite difficult to identify each purpose of the *gers*. This study assumed all *gers* are used for residential purposes. GIS data relating to houses and rivers were produced from IKONOS imagery for 2000 and QuickBird imagery for 2008. IKONOS and QuickBird have spatial resolutions of 1.0–4.0 and 0.6–2.8 m^2, respectively, and have the ability to spatially identify even a small *ger*.

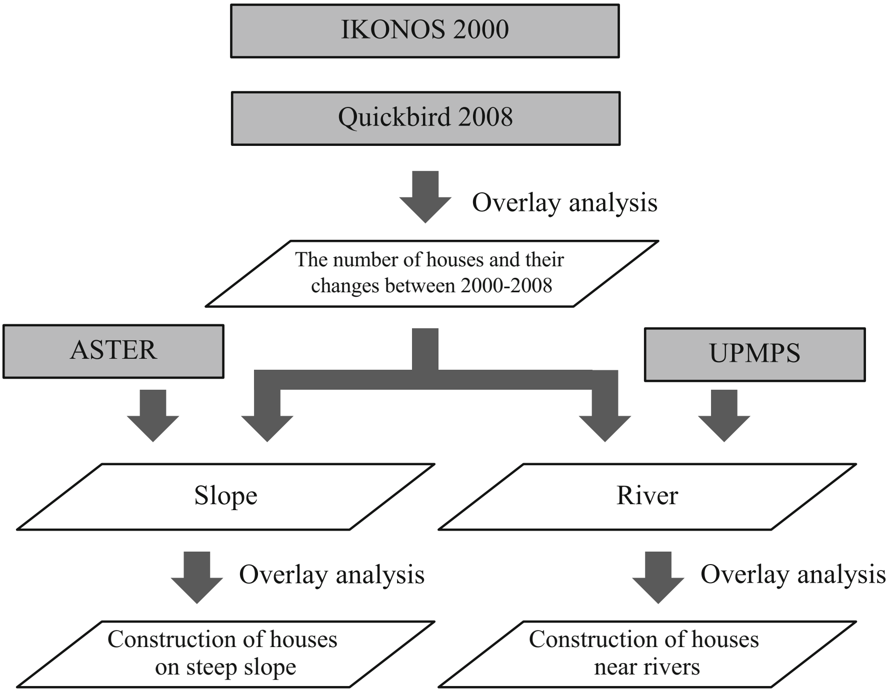

Fig. 8.3 The flow of data processing and construction by overlay analysis

In this analysis, these images for 2000 and 2008 were used to compare the characteristics of the changes before and after the implementation of the land reform policy. We identified each of the houses on the imageries and digitized them manually in a vector format along with the rivers according to the imageries for the observed years (Fig. 8.4). In addition to VHR satellite imageries as our primary data sources, for the analysis we utilized supplementary GIS data constructed through the international donor project implemented by the JICA, entitled "The Study on City Master Plan and Urban Development Program of Ulaanbaatar City" (UBMPS). These data were obtained previously through the Second Ulaanbaatar Services Improvement Project, which was one of the primary donor projects in Ulaanbaatar implemented by the World Bank in 2007 and subsequently utilized and modified by the JICA (JICA 2009; Tsutsumida et al. 2015). Finally, an ASTER GDEM dataset in which cloudy pixels were removed and residual anomalies corrected was prepared for the analysis.

As mentioned above, according to JICA (2002), the areas prone to flash floods are identified topographically near rivers or on steep slopes, and thus the changes in the number of houses in these vulnerable areas were calculated by overlay analysis. In the results, during the period 2000–2008, the number of houses had increased drastically from 4900 to 15,246, showing an increased rate of 311.1 % in the study

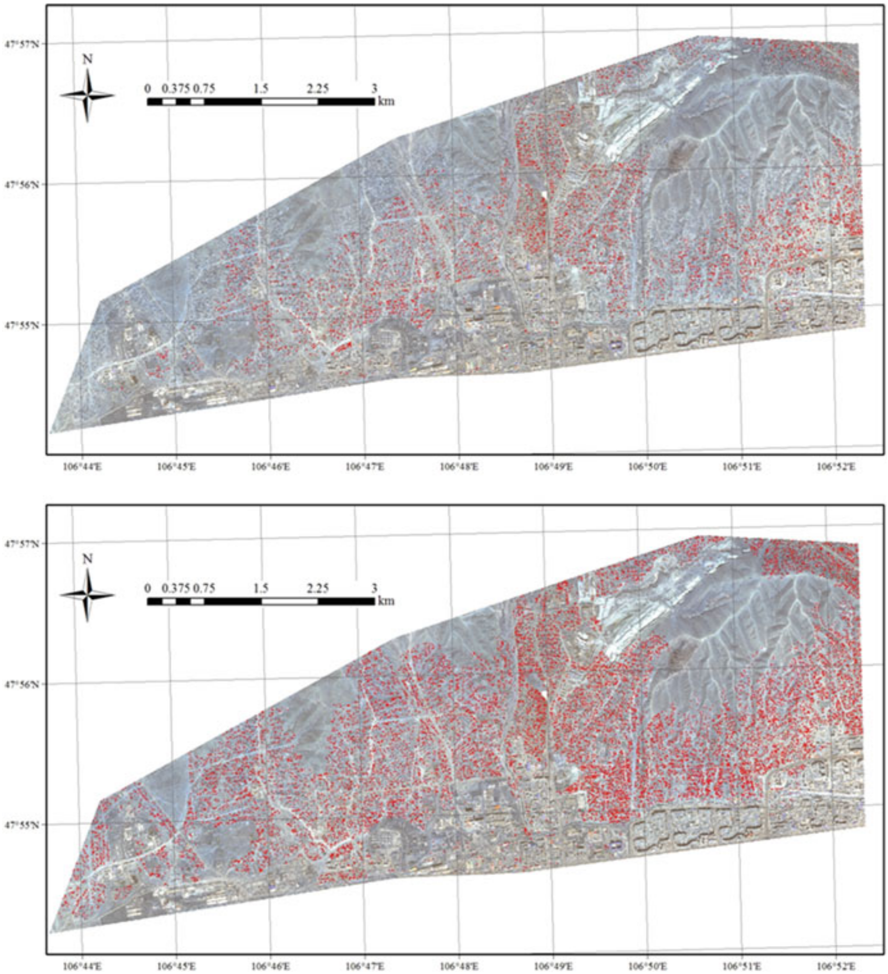

Fig. 8.4 Ger distribution (*red color*) derived from IKONOS in 2000 (*upper*) and from QuickBird in 2008 (*lower*)

area (Fig. 8.4, Table 8.1). The change rate within 50 m from rivers (378.8 %) is significantly higher than the average in the study area. Those results revealed spatial developments of house construction on the flash-flood-prone areas. Although the increasing rates within 100 m and 200 m from rivers are slightly lower than those within 50 m, both rates are still higher than average.

In addition, the increased number of houses was high in the areas with steep slopes of more than 8 degrees. Compared to the less steep areas, the change rate is higher, and this result indicates that even if the land was on a steep slope, people construct houses without taking the hazardous nature of the topography into account.

Table 8.1 The number of *gers* in 2000 and 2008 and their change rates by distance from rivers and by degrees of slope

	The number of *gers* in 2000	The number of *gers* in 2008	Change rate (%)
Total area	4900	15,246	311.1
Distance from rivers within 50 m	297	1125	378.8
Distance from rivers between 50 and 100 m	393	1140	290.1
Distance from rivers between 100 and 200 m	725	1917	264.4
Distance from rivers more than 200 m	3485	11,064	317.5
Slope (0–3 degree)	1348	4114	306.0
Slope (3–8 degree)	2978	8966	301.8
Slope (8–degree)	574	2166	378.4

Fig. 8.5 *Gers* construction on steep slopes by digging and developing lands (Photo by Saizen in August 2011)

Throughout the field survey in 2011, the typical construction of *gers* on steep slopes was observed as shown in Fig. 8.5. The lands on the steep slope were dug and developed for the *ger* construction. After the construction, people enclosed their land by *khashaas* and occupied their private lands (in some cases, unregistered), thus forming new *ger* areas as a result.

8.5 Discussion and Conclusion

By focusing on the topographical features where the disorderly formation of *ger* areas had been detected, this chapter has introduced one example of uncontrolled land use and its associated changes. Uncontrolled land use increases vulnerability to flash-flood hazards in Ulaanbaatar. Political and social events, the shift to a free market economy and land privatization, and the natural hazard event—*dzud*—are factors that have led to considerable migration to Ulaanbaatar. Since many migrants have not registered as citizens, official statistics do not yet reflect actual conditions of houses in flash-flood-prone areas, which were revealed in the spatial analyses through maximum utilization of VHR satellite imageries. Tsutsumida et al. (2015) pointed out that the distance from roads appeared to be one of the primary forces governing the formation of *ger* areas in terms of spatial formation patterns. In response to residents' demands for better access to social and political infrastructure, most of the roads in *ger* areas began as informal tracks to private land. Arguably, residents' first priority in selecting their place of residence is not security from hazards but accessibility to urban areas. Tsutsumida et al. (2015) also indicated that social infrastructure influences the formation of *ger* areas much more strongly than topographical factors. In particular, houses are newly constructed near water kiosks which are normally established in areas where residents had difficulty accessing other water supplies. Yet some of these homes are built near rivers or on steep slopes, both of which are prone to flash floods. Figure 8.6 is one example and is a typical area where many houses were constructed near a river during the observed periods.

In addition to flash floods, the lack of a proper drainage system also results in frequent flooding. The problem is exacerbated by the fact that residents in *ger* areas often dispose of garbage irresponsibly, which creates an obstacle to water drainage and leads to flash floods (Uddin et al. 2014). The first priority should be to restrict the construction of houses in areas that are prone to flash floods by creating a zoning

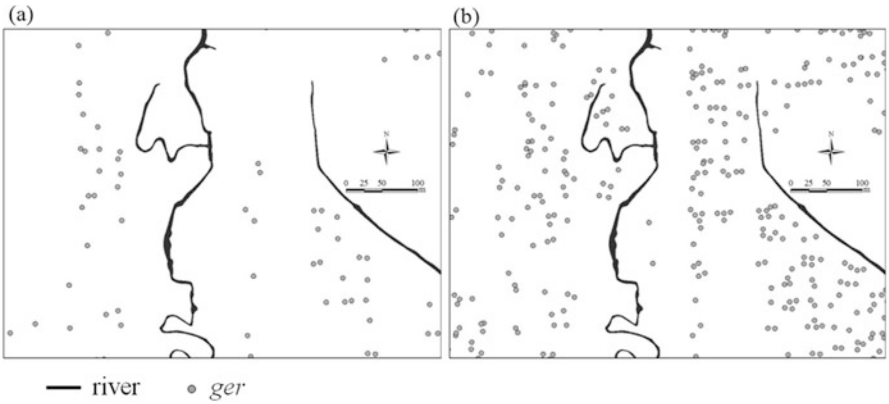

Fig. 8.6 The distribution of *gers* around rivers in (**a**) 2000 and (**b**) 2008

system from the viewpoint of topography. Then, through detailed investigation, proper land use planning—which has not previously existed in *ger* areas—should be established. In addition to these top-down approaches, community and private sector engagement are essential. Most residents in *ger* areas are from outside Ulaanbaatar so that their networks and mutual cooperation are quite weak. This situation would trigger illegal *ger* construction or migration into *ger* areas even if land use planning is established. Well-considered bottom-up planning based on social circumstances and disaster management is urgently needed. Vision is currently lacking in the management and infrastructure programming in *ger* areas. It seems reasonable to conclude that community development programs involving private sectors should be provided to absorb their opinions and strengthen their mutual cooperation in parallel with top-down approaches. The Mongolian government should not only develop legal systems for *ger* areas formation but also conduct initial inquiries and develop bottom-up approaches immediately.

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Chapter 9
Integration of Disaster Risk Reduction into Land Use Planning: Experience of Bangladesh

Sunil Prashar and Md. Anisur Rahman

Abstract Bangladesh is highly exposed to different kinds of natural hazards, including cyclone, flood, landslide, and drought. Due to its geographical location and historical evidence of seismic events, the country is considered to be highly vulnerable to earthquake, especially its fast-growing urban centers. Rapid urbanization without proper guidance has led to haphazard development of many urban centers. The risk is growing in urban centers due to the fact that the development is taking place in the areas that are vulnerable to hazards, such as earthquake, and there is a clear absence of disaster risk assessment as a part of the land use planning process. This chapter addresses this gap by discussing one of the key initiatives of the Urban Development Directorate, Bangladesh, and Asian Disaster Preparedness Center, Bangkok, to encourage disaster risk reduction-inclusive land use planning in Bangladesh. This initiative is a research project, which aims at sustainable development for urban centers by making land use planning in Bangladesh disaster risk reduction inclusive. It investigates the integration of disaster risk reduction into physical/land use planning with a specific objective of promoting risk assessment in the plan preparation. The key outcomes of this project include a framework for integrating disaster risk reduction into the methodology of land use plan preparation in Bangladesh, a comprehensive list of hazard data required for land use/physical plans in the country, and key recommendations for future improvements of integration of disaster risk reduction into land use planning in Bangladesh. Moreover, the outcomes have been applied in the preparation of the Mymensingh Strategic Development Plan. Further, the chapter also discusses the overall challenges and issues related to preparation of urban land use plans in Bangladesh by the urban development authorities and municipalities and how such issues and challenges may influence the implementation of project outcomes. Finally, the conclusion and way forward discusses issues and options for addressing the risk of the urban poor community through risk-inclusive land use planning in general as well as in Bangladesh.

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Keywords Urban risk • Land use planning • Disaster risk reduction • Bangladesh

9.1 Introduction

Bangladesh is highly exposed to different kinds of natural hazards, including cyclone, flood, landslide, and drought. In addition, in urban areas, floods, earthquakes, heat island effect, and fire are very common. Due to its geographical conditions and past natural hazard events, urban centers of Bangladesh are emerging as a hub of disaster risks (Parvin et al. 2013). Since 1869, seven severe earthquakes of magnitude 7.0 or above have occurred, for instance, the Bengal earthquake of 1885, Great Indian earthquake in 1897, and Srimangal earthquake in 1918, where the epicenters were located within Bangladesh (Paul and Bhuiyan 2010). The country is located close to two active tectonic plates: the Indian plate and the Eurasian plate, and the past events of collision of these plates have made the whole region, which is also known as the Himalayan and Burmese mountain belts, regarded as one of the most intensively active seismic regions in the world (Paul and Bhuiyan 2010). In the recent past, Bangladesh did not experience any major earthquake; however, the rapid pace of development and trends of urbanization have transformed many of the urban centers vulnerable to earthquake. An updated zoning map based on an analytical study confirms that a major earthquake event in Dhaka may lead to massive loss of life and damage to buildings (Rana 2011; Sharfuddin 2001). Moreover, a recent study by Stanford University on the Earthquake Disaster Risk Index ranks Dhaka among the 20 cities most vulnerable to earthquake in the world (World Bank 2013).

Similarly, urban centers in Bangladesh are also vulnerable to flooding as most of them have grown along the riverbank, low-lying marshy lands, mining or industrial hubs, and steep slopes (Parvin et al. 2013). The flood of 2004 in Dhaka affected around 2.5 million of the population and 20 people died (Rana 2011; Islam and Hasan 2004). As per the report of the Center for Urban Studies (2006), 60 % of slums in the city were affected by floods, in which 38.5 % were fully affected. Moreover, Rashid (2000) noted that the poor inhabitants in Dhaka city are mostly vulnerable to flood hazard. Furthermore, a study on the Climate Change Vulnerability Index, 2013—“most at-risk cities”—conducted by Maplecroft ranked Dhaka as top among seven surveyed cities (Maplecroft 2013).

The urban risks in Bangladesh are growing not only due to its geographical locations or hazard events but due to two interlinked drivers, namely, ineffective land use planning, which allowed development of settlements and infrastructure in the locations that have a high likelihood of experiencing a natural disaster (King et al. 2013), and uncontrolled urbanization, which occurred mainly due to high rate of rural to urban migration (Burkart et al. 2008; Rana 2011). Eventually, when migrants arrive, for example, in Dhaka, they often end up living in slums, where 40 % of the city’s population lives (Cities Alliance 2014). Moreover, around 300,000–400,000 new poor migrants arrive in Dhaka in a year (World Bank 2007a). Finally, ineffective land use planning in urban areas of Bangladesh led to an increase in physical exposure to natural hazards, and for several years, most dwellings in the urban centers have grown without following adequate standards of land use planning. As a result, hazard exposure and vulnerability of people, infrastructure, and system in the urban centers of Bangladesh have increased due to ineffective land use planning. The World Bank (2007b) also noted the ineffective land use planning factors, including poorly informed plan preparation process, inappropriate survey design, and inadequate allocation of technical resources.

In this context, the chapter focuses on integrating disaster risk reduction (DRR) into land use planning in Bangladesh, a research project carried out by the Urban Development Directorate (UDD), Bangladesh, and Asian Disaster Preparedness Center (ADPC), Bangkok. The project aims at sustainable urban development by making land use planning more DRR inclusive. Thus, it investigates the integration of DRR with a specific objective to promote risk assessment into land use planning preparation in Bangladesh.

The first section of this chapter focuses on the literature review of DRR and land use planning, followed by describing the land use planning approach to DRR. The next section explains urban land use planning in Bangladesh and its implications for climate and disaster risks, which is followed by integration of DRR into land use planning in Bangladesh: a research project. Finally, the last section deals with the conclusion and way forward.

9.2 Disaster Risk Reduction and Land Use Planning

DRR aims at reducing the adverse impacts of natural hazards and disaster risks by addressing two main elements of risk, namely, hazards—the potential damaging events or phenomenon—and the vulnerability of populations to these hazards. It is defined by Twigg (2004) as “the broad development and application of policies, strategies and practices to minimize vulnerabilities and disaster risks throughout society, through prevention, mitigation and preparedness.” The DRR policies and strategies, which evolved from 1970s, build on the assumption that natural hazards themselves do not cause disasters but it is the combination of an exposed, vulnerable, and ill-prepared population or community with a hazard event that results in a disaster, in other words, disaster as origin of socioeconomic and political processes (Gaillard et al. 2007; Hewitt 2007; Mercer 2010; Torry 1978, 1979; Wisner et al. 2004). The strategies include hazards, vulnerability, and capacity assessment, which are multidisciplinary in nature (Mercer 2010; Tran and Shaw 2007; Wisner et al. 2004) and cannot be limited to single scientific field. They can also be applied in the land use planning tool for achieving sustainable urban development by making land use planning more DRR inclusive. Moreover, in this direction, several initiatives have been already taken, such as the Hyogo Framework (2005–2015), which sets out DRR strategies for reducing disaster risk through five priorities of actions.

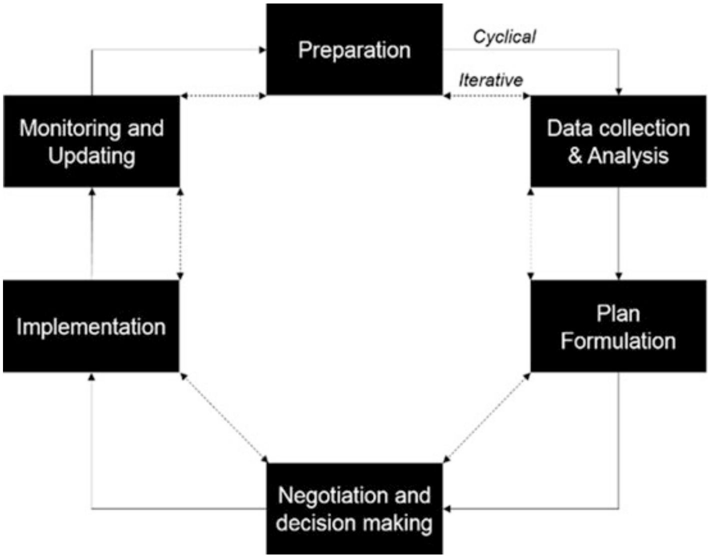

Fig. 9.1 Land use planning as iterative and cyclical (Adopted and modified from GIZ 2011)

Tasks 14 and 15 of the Hyogo Framework for Action (HFA) priority 4 (i.e., reducing underlying risk factors) clearly set out local and national indicators, guiding questions and tools for incorporating DRR in urban and land use planning and strengthen mechanisms for improved building safety and protection of critical facilities (Kyoto University et al. 2010). Similarly, Sendai Framework for DRR (2015–2030), under priority 3 (i.e., investing in DRR for resilience), clause F (pp.15), aims to "promote the mainstreaming of disaster risk assessments into land use policy development and implementation, including urban planning, land degradation assessments and informal and non-permanent housing" (United Nations 2015). Such global initiatives have already benefited several national and local governments and communities to be resilient by practicing DRR-inclusive land use planning, but studies have also found the downsides of such integration, especially in developing countries. Before discussing the benefits and downsides of integrating DRR into land use planning, the section first briefly describes an overview of land use planning.

As defined by Food and Agriculture Organization (FAO 1993), "land use planning is the systematic assessment of land and water potential, alternatives for land use and economic and social conditions in order to select and adopt the best land-use options. Its purpose is to select and put into practice those land uses that will best meet the needs of the people while safeguarding resources for the future." It is not a straight step-by-step procedure but an iterative and cyclical process with interlinked phases as shown in Fig. 9.1 (GIZ 2011).

The best land use options are defined by the goals of land use planning, which are often based upon three elements: efficiency, equity and acceptability, and sustainability (FAO 1993). The elements are based on the key principles of land use planning, which include sustainability balancing social, economic, and environmental needs; results in a legally binding land use plan; integrated into state institutions having the official mandate for inter-sector planning; an all-inclusive process; based on stakeholder differentiation and gender sensitivity; takes into account traditional strategies for solving problems and conflicts; integrates bottom-up aspects with top-down aspects; based on interdisciplinary cooperation and requires sector coordination; requires transparency; an iterative process and relates to spaces and places, among others (GIZ 2011). Unfortunately, these principles are inconsistently applied by the developing countries.

In developing countries, the history of land use planning has evolved in three different phases (GIZ 2011), namely, top-down scientific land use planning by experts (phase 1), participatory land use planning (phase 2), and incorporation of land use issues in existing management mechanisms (phase 3). Unlike phase 1 and 2, the third phase is most ideal due to its key characteristics, which include participatory processes that are carried out from the beginning with repetition and scaling-up strategies, utilization of local experience and good stakeholder coordination, and public debate for preparing sophisticated plans, connection to financial mechanisms, and provides ideal conditions for land use to be regulated by laws. The key characteristics as well as the constraints in land use planning in developing countries put some nations ahead of others in terms of time spent in each of the three phases of land use planning (GIZ 2011). Conversely, in developed countries, most land uses are regulated by laws which limit the space for planning interventions (GIZ 2011). With such differences, when land use planning is utilized as an effective tool for addressing the disaster risks through integration of DRR elements, it is essential to understand the benefits and downsides of such initiative.

9.2.1 What Are the Key Benefits of Integrating DRR into Land Use Planning?

As discussed in Sect. 9.2, the Hyogo Framework sets out DRR strategies and priorities (i.e., tasks 14 and 15) that encourage all countries to integrate DRR into land use planning. One of the significant benefits of integrating DRR into land use planning, as highlighted in HFA, is the significant reduction in the vulnerability, which is defined as conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards. The citizens, potential investors, and government officials are benefited through knowledge about the limitations of hazard-prone areas (Burby et al. 2000). Finally, it can also help a community to become more resilient through (i) intelligence about long-term threats posed by natural hazards to the safety and viability of human development and environmental resources; (ii) problem solving to cope with imminent threats prior to, during, and after a disaster; (iii) advance planning to avoid or mitigate harm from a future disaster and to recover afterward; (iv) management strategies to implement plans through policies, regulations, capital improvements, acquisition, and taxation (Burby et al. 2000).

9.2.2 What Are the Downsides of Integrating DRR into Land Use Planning?

While several countries, particularly developed, have successfully benefited as a result of integrating DRR into development planning and reduced their vulnerability and exposure to natural hazards, there are countries, particularly developing ones, which have experienced the downsides of integrating DRR into land use planning. The downsides are experienced in the form of transfer of losses and risks from rich to poor; for example, the Thailand flood in autumn 2011 following Tropical Storm Nock-ten and heavy monsoon rains was managed to avoid flooding in the wealthy financial centers to the expense of its outskirts, affecting Thailand's manufacturing industries and poor local residents (*Bangkok Post*, November 28, 2011). Studies revealed that economic pressures and lack of institutional capacity are the root causes for such downsides of integrating DRR into land use planning (Sudmeier-Rieux et al. 2013). For example, Sudmeier-Rieux et al. (2013) analyzed the opportunities, incentives, and challenges to risk-sensitive land use planning—lessons from Nepal, Spain, and Vietnam—and found that land use planning will only be as strong as the institutions which lead it, as demonstrated in all three countries (Sudmeier-Rieux et al. 2013). The case of Vietnam shows that private real estate interests prevailed over regulations due to weak planning and enforcement mechanism. Similarly, very weak state of institutions in Nepal provided a planning vacuum, filled by private informal settlements in dangerous areas. In Spain, due to the absence of strong visions of local institutions toward environmental consideration at local level, the risk-prone development is encouraged by the high-level administration that has political and technical capacity to change the land use provision. Another example of the downsides of integrating DRR into land use planning is the limitation of regulatory approaches as they are often ineffective in developing countries with the growth of mega-cities. In some way, the narrow focus of land use planning in developing countries (see Sect. 9.2) is also one of the contributing factors responsible for such situation. Finally, it is essential that in developing countries, any risk-integrated land use planning approach should find a right mix of regulatory, financial, and other incentives, which means that urban expansion and redevelopment of locations will be free from hazards by eliminating the possibility of damages through integrating DRR into land use planning programs (Burby 1998; Sudmeier-Rieux et al. 2013). The following section discusses land use planning approaches to disaster risk reduction.

9.3 Land Use Planning Approach to Disaster Risk Reduction

Land use planning is one of the most promising approaches for reducing losses in natural disasters by reducing vulnerability to natural hazards (Burby et al. 2000; GIZ 2011; Kyoto University et al. 2010). Several studies, including EM-DAT noted that economic losses in urban areas are higher than rural areas due to natural disasters, which means that urban investment made through land use planning must be re-looked from risk angle. Land use planning approach to DRR is an effective tool that can be used to minimize such risk as it affects both the vulnerability of the population and infrastructure and natural hazards (GIZ 2011). It states that DRR should be integrated into all phases of the land use planning process (Fig. 9.1). To achieve greater sustainability, it should also take into consideration future risks which may occur due to climate change impacts (GIZ 2011). This section discusses the DRR tools, which can be integrated into the preparation or implementation of land use plan (GIZ 2011).

9.3.1 Risk Assessment

Risk assessment includes both the quantitative and qualitative information derived from hazard identification, vulnerability assessment, and risk analysis (Burby et al. 2000). Hazard identification is the basic essential foundation upon which all risk assessment is based, whereas vulnerability assessment combines the information from hazard identification with an inventory of the population at risk. Risk analysis includes both probability assessments of various intensities of a hazard and probability assessment of impacts on population, structures, and properties (Burby et al. 2000). Integrating risk assessment in land use planning can help in identifying land use that may experience natural hazards at various intensities (GIZ 2011). Hazard identification presented through map can be used to define regulatory zones, where different development and construction standards are implemented, and it can be also used to identify the property or structures to be acquired or relocated for hazard mitigation purpose (Burby et al. 2000). Similarly, vulnerability assessment can be used as a basis for developing hazard management policies and programs under land use planning (Burby et al. 2000). Such information provides the factual basis for land use decisions taken by local government strategic planning (King et al. 2013). Thus, risk assessment should be integrated into the baseline assessment of land use planning for planning and mitigation purpose (Burby et al. 2000; GIZ 2011).

9.3.2 Risk Mapping

Risk map produced during the risk assessment process can be very useful for creating development regulations, which are risk sensitive. Development regulations (i.e., variety of land use regulations) include zoning, subdivisions, critical areas, landscaping, planned unit development, sign, and environmental protection (MRSC 2015). They are the tools, which govern the location, type, and intensity of new development (Burby et al. 2000). Thus, risk mapping can be effectively used in creating an environmental zoning standard, which can be implemented to avoid unplanned and haphazard development (UNISDR 2012). For example, the Regional Flood Management and Mitigation Center of the Mekong River Commission with the support of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) on behalf of the Federal Ministry for Economic Cooperation and Development and GFA Consulting developed an approach on flood probability-based land use zoning in Cambodia (Falke 2010). With this approach, four different zones with different flood depths and durations have been developed and later used in the land use management policy (Falke 2010).

9.3.3 Disaster Risk Reduction Measures

DRR measures (i.e., structural and nonstructural) should be integrated into land use planning options (ADPC 2011). Building standards are the important land use planning options, which regulate the details of building construction (Burby et al. 2000). Few common building standards include traditional building codes, retrofitting requirement for existing old buildings, flood-proof requirements, seismic design standards, construction standards, performance standards, road standards, height zoning standards, and facility standards, among others (Burby et al. 2000). As an example, when designing and building regulation for flooding, application of appropriate building controls should consider elevation standard, high foundation walls, stilts, pilings, setbacks, and minimum lot size depending on risk levels (ADPC 2011). Similarly, settlement design, for example, aims to promote resilient design, safer construction, and strengthening of nonengineering buildings, using low-cost techniques and local available materials (UNISDR 2012). It can restrict flood, flash flood, and surge control, through settlement layouts, height of houses, road design, and design and landscaping of drainage and flood retention areas. It enhances DRR in the recovery phase (Donovan 2013).

In addition to building standards and development regulations, there are other planning tools where DRR measures (including risk assessment) can be integrated and which allow planners to adopt approaches to mitigate hazards. These tools include policies for critical and public facilities, land and property acquisition, taxation and fiscal policies, and information dissemination (Burby et al. 2000). For example, when risk assessment is integrated into policies for critical and public facilities, it will allow the locations of schools, other public facilities, streets, and public utilities in hazard-free sites which may facilitate other growth in the safe zone (Burby et al. 2000). Similarly, land and property acquisition can be used to covert hazardous properties into less hazardous uses, for example, acquisition of underdeveloped lands, development rights, and damaged buildings to reduce the development or to promote design that reduce vulnerability (Burby et al. 2000). Taxation and fiscal policies can be used for reducing land use intensities in hazardous areas and taxes for hazardous area development (Burby et al. 2000). Finally, to enable people and public officials to make safe choices about the location and urban development, information dissemination tools play significant role (Burby et al. 2000). Information dissemination programs include public information, education of construction professionals, hazard disclosure requirements in real estate transactions, and construction of warning signs inform people about the hazard locations (Burby et al. 2000).

The success of implementing DRR-integrated land use planning depends upon the effective role of central and state governments in influencing land use and development. In some countries decentralization led to the empowerment of local governments. For instance, local governments through planning powers can build community agreement on a DRR-inclusive land use plan. Similarly, they can implement DRR-inclusive zoning, subdivision regulations, building codes, design standards, urban growth boundaries, and wetland and floodplain regulations through regulatory power. Thus, local governments have a strong role and responsibility in creating a strong institutional and administrative framework for a city which include preparation of awareness campaigns; coordination of risk assessments and disaster risk reduction plans; ensuring that resilience planning is part of city's development plans, its strategies, and projects or resource mobilization; and tracking the progress (UNISDR 2012). The other success factors include successfully establishing development principles or "Development Management Principles" (Burby et al. 2000), which include using clear and authoritative maps of the hazards, linking clear and realistic design guidelines to the maps, ensuring that hazard-free land is available for development, offering incentives to encourage developers to locate projects outside of hazardous areas, and adopting hazard DRR measures that exceed those required by law, among others (Burby et al. 2000). Establishing such principles also require strong commitments from local governments as well as support from national government and other key stakeholders.

9.3.4 Key Challenges and Issues

Although the approach discussed earlier aims to integrate DRR into land use planning and seeks to achieve sustainable, resilient development, there are real challenges and issues that need to be understood for promoting greater integration of DRR into land use planning. Even with or without DRR-inclusive land use planning, some issues and challenges require careful consideration. The most common issues and challenges include when affected communities are not allowed to participate in decision-making in planning, which drives risk in urban areas; land use decision may push risks higher when a large number of population find accommodation in informal settlements, which are often located in hazard-prone areas; land use planning in low- and middle-income countries have excluded many urban people from legal land and housing markets, thus increasing urban risk; and finally, poor households in informal settlements are often excluded from public investments in vital risk-reducing infrastructure and services (UNISDR 2011).

Sometime land use regulations that prohibit development in hazard-prone areas are misused to exclude low-income households from well-located land. For example, in the state of Buenos Aires, Argentina, a law to conserve the natural drainage was introduced in 1957, which prohibited construction within 50 m of rivers, streams, and canals, and later it was amended in 1977, by saying that houses must be built above a certain elevation to obtain planning approval (UNISDR 2011). This law was very inflexible as it provided no alternate solution for flood risk reduction, and when it was introduced, the cost of land suddenly increased, which excluded many low-income households from the land market.

Moreover, it is often observed that most settlements in the urban areas breach building codes as the local bylaws stipulate the use of cement, mortar and steel, and electrical and sanitary installations, which are beyond the reach of most urban households (UNISDR 2011). Sometimes even the appropriate building codes are inappropriately supported by legislation and enforcement; for instance, before the Gujarat earthquake of 2001, compliance with existing codes was not required by law except for government buildings (UNISDR 2011).

9.4 Urban Land Use Planning in Bangladesh and Its Implications to Climate and Disaster Risks

The section discusses the urban land use planning in Bangladesh, and later it analyzes how it has promoted an increase in climate and disaster risks in the country.

9.4.1 Urban Land Use Planning in Bangladesh

The total area of Bangladesh is 14.75 million hectares (Dey et al. 2012), including agriculture, forest (state and private), urban, water, and others. Out of this total area, 7.9 % is urban, where 25 % of the country's population lives and half of them inhabits in four major cities: Dhaka, Chittagong, Rajshahi, and Khulna.

Urban areas in Bangladesh have different kinds of local governments; for instance, the four largest cities and smaller cities have a city corporation status and

Table 9.1 Classification of urban areas in Bangladesh

City corporation	11 (Dhaka North, Dhaka South, Gazipur, Narayanganj, Chittagong, Comilla, Khulna, Sylhet, Barisal, Rangpur, and Rajshahi
Pourashavas (municipalities)	318
Category	Annual income level
Class I *Pourashavas*	>6 million BDT + (income per year over last 3 years)
Class II *Pourashavas*	2.5–6 million BDT (income per year over last 3 years)
Class III *Pourashavas*	1–2.5 million BDT (income per year over last 3 years)

1 BDT equivalent to 0.0128617 US dollar (US$)
Source: Local Government Engineering Department (n.d.); XE currency converter (May 24, 2015)
BDT Bangladeshi Taka

the rest are known as *Pourashavas* or municipalities, which again are classified according to financial strength as shown in Table 9.1 (ADPC et al. n.d.). Also, few urban centers are under Cantonment Board. Finally, the population of some urban areas is more than their class, but they are still under the same classification category and not upgraded.

In terms of local administration, larger cities are governed by city corporations. Both city corporations and *Pourashavas* (municipalities) form two types of local governments, and their functions are basically similar with one important difference, which is related to the functions. Ordinance 1997 categorized functions of *Pourashavas* as compulsory and optional (ADPC et al. n.d.). In reality, *Pourashavas* often fail to perform their functions due to lack of enough funds due to poor and irregular collection of taxes; nonrealization of taxes from various governments, including semi-government and autonomous organizations; and insufficient grants from governments. Moreover, this has also affected their functions in planning for DRR, building community resilience, and disaster recovery.

The history of urban planning in Bangladesh along with another part of Bengal dates back to the third century B.C. There were a number of towns and settlements that served as the Center of Administration and Transport during the period. The first planned settlement in the part of Bangladesh started with the establishment of Pundunagar (popularly known as *Mahasthangarh*), and the other contemporary planned developments during the ancient period include Panchanagri in Dinajpur; Paharpur in Naogaon; Mainamati near Comilla, Chittagong; Kotalipara in Faridpur; and Savar and Subarnagram in Dhaka (Mohit 1991). Although the ancient settlements were not in large scale, still these are signs of early planned development in this region. Present urban planning follows the legacy of the British and the Pakistani town planning traditions, which came after Mughal period (Nazem 2013). The following section will focus on the present urban planning system in Bangladesh by discussing its institutional arrangements, legal arrangements, and planning system and some key issues.

9.4.1.1 Institutional and Legal Arrangements for Urban Planning

After the partition of British India in 1947, the pattern of urban growth reveals that urban population had a modest increase, but its distribution showed signs of concentration in large centers such as Dhaka and Chittagong (Mohit 1991). However, the urgency of planned development was felt during this period due to the large number of refugees' movement. During this period planned development initiative started with some subdivision plans to resettle the refugees.

In addition, the government had to take up various development works throughout the province, resulting in the establishment of new offices in the government as well as for autonomous bodies and construction of staff quarters for them. Simultaneously, commercial and industrial activities started to gain momentum creating job opportunities in the existing urban centers causing an influx from rural areas. All these factors combined together created insanitary living conditions and acute congestion in the already overcrowded areas of the towns. Whatever shelter and houses people created within the town and in their fringes in the absence of proper planning only led to the creation of slums and contributed toward an unplanned extension of the towns (UDD 1968).

For planning and development, the government created three statutory bodies in the metropolitan areas, namely, Dacca Improvement Trust (DIT), presently RAJUK in 1956; Chittagong Development Authority (CDA) in 1959; and Khulna Development Authority (KDA) in 1961. The three areas together accounted for about 47 % of the total urban population of the province in 1961. Besides this, under the Ministry of Housing and Public Works, the Housing Wing was created in 1958 to rehabilitate the refugees and to provide housing for the Public Government of East Pakistan.

Moreover, with the view of urgency for planned development in the other urban centers of the country, the Government of East Pakistan created a new organization, called Urban Development Directorate (UDD) within the Works, Power and Irrigation Department in 1965, and transferred all the incumbents working in the Town and Country Planning and Survey, Investigation and Planning of Rural Housing Schemes of the Housing Wing to this newly created directorate.

Currently, there is no national physical plan for guiding spatial development of the country. UDD took initiative for formulating Urban Land Use Policy in 2011; however, it is yet to get a final shape. Urban development of Dhaka city and Narayanganj is guided by the Town Implementation Act of 1953. Chittagong, Khulna, and Rajshahi cities are guided, respectively, by CDA Ordinance 1959, KDA Ordinance 1961, and Rajshahi Town Development Authority Ordinance 1976. UDD is responsible for preparation of urban land use plan for all urban centers in the country except the jurisdiction of RAJUK, Chittagong, Khulna, and Rajshahi Development Authority. The Bangladesh National Building Code (BNBC), a guiding document for building construction in the country, was formulated in 1993, which became an Act in 2007. It was established to set up the minimum standard for design, construction, quality of materials, use and occupancy, location, and maintenance of all buildings within Bangladesh in order to safeguard within achievable limits of life, health, property, and public welfare (Islam and Hossain 2013).

9.4.1.2 Planning System

Modern-day urban planning started with Dhaka Master Plan of 1959 and Master Plan for Chittagong and Khulna in 1961. All these master plans were traditional land use plans for a period of 20 years. While preparing Dhaka Master Plan, the planners' assumed 40 % population growth for Dhaka for the 20-year planning period, with a target figure of 1.47 million in 1979. However, a dramatic change in the number of population and development took place when Dhaka became the national capital after independence of Bangladesh in 1971. By the year 1979, the Dhaka population became almost three times more than the estimated figure of 1.47 million. At the end of the Master Plan of 1959, strategic planning effort was initiated in 1979 by the Bangladesh Planning Commission, jointly funded by the Asian Development Bank, United Nations Development Programme, and Government of Bangladesh, to undertake a project to prepare a long-term urban development strategy to guide and regulate the future growth of the Dhaka Metropolitan Area, particularly the Dhaka City. Under this project a 20-year Dhaka Strategic Plan was prepared for Dhaka City in 1981. It was the first-ever strategic plan for a city in Bangladesh. In 1995 a 20-year planning package was initiated in Dhaka and its adjoining area of about 590 mi^2 named as "Dhaka Structure Plan." This planning package has three components, namely, Structure Plan for 20 years, Urban Area Plan for 10 years, and Detail Area Plan (DAP), for 3–5 years. Similar approach of planning package has been adopted in other cities and towns in the country, respectively, by Development Authorities, UDD, Local Government Engineering Department (LGED), and municipalities. LGED mainly helps municipalities in getting their plans prepared by the consultants.

9.4.1.3 Planning Practices and Implementation: Key Issues

Nazem (2013) noted that planning practices in Bangladesh have not grown matching with the urban growth. For example, the total urban population in 1971 was 5 million, which increased to 38 million in 2011 (Nazem 2013). In other words, the town and cities have grown from 108 to 532 in 2011. The urban planning practices failed to deal with such massive increase in population; for instance, the Master Plan of Dhaka failed or became a useless document as a result of increase in population, beyond the target population of the master plan. Thus, cities expanded in a haphazard way; for instance, in the absence of adequate housing and land use policy, the slums started expanding in the hazard-prone areas.

Similarly, implementation of plan took a lot of time; for example, between 1984 and 1991, UDD successfully completed preparation of massive plans for 50 district towns and 392 Upazila towns (Nazem 2013), but none of these plans were implemented. Thus, urban centers and small towns have grown without a plan. With regard to BNBC, since 1993, it was never really amended to keep the pace with more advanced technologies in building standards for renewable energy use, rainwater harvesting, and reducing energy demand, among others (Nazem 2013).

The past growth of urban planning in Bangladesh has also increased climate and disaster risks in urban areas, and it is very important for the urban planners to understand that what human factors apart from natural factors responsible for such situation. The next section will primarily focus on understanding major implications of past urban land use planning in Bangladesh on climate and disaster risks.

9.4.2 Implications to Climate and Disaster Risks

As discussed earlier, in the context of climate and disaster risks, the role of land use planning is crucial for DRR. How land is used in urban areas and how infrastructure and services are designed and constructed influence exposure to natural hazards (UNISDR 2011). In case of Bangladesh, several factors related to urban land use planning are responsible for increase in disaster and climate risks, such as failure of dealing with disaster issues directly in urban land use plan preparation; BNBC is weak in dealing with climate risks, a large population size lives in slums that are located in hazard-prone areas, and indiscriminate earth-filling activities in Dhaka. The following section briefly discusses these factors in detail.

9.4.2.1 DRR: Not Directly Addressed in Land Use Plan Preparation

Unless land use plans are DRR inclusive, they may not be able to bring desired change on the ground. In the past, since master plan and other tiers of plans prepared, natural hazard was given priority, but it has been addressed as supplementary topic with other issues (UDD 2013). Moreover, the plans did not address all hazards; for instance, seismic risk was missing in all tiers of planning. The implementation of such land use plans has already created significant impacts by increasing disaster risks in the urban areas of Bangladesh. A systematic methodology that incorporates DRR into land use plan preparation comprehensively is most important, which also means that careful consideration is required to integrate risks into different steps of land use plan preparation.

9.4.2.2 Violation of Building Code

Since 1993 when BNBC was created as an instrument for development control mechanism, it remained weak in implementation for several decades. Moreover, it also means that before 1993, Bangladesh has grown without proper comprehensive standard building code. The representatives of the Comprehensive Disaster Management Program (CDMP), under the Ministry of Food and Disaster Management of Bangladesh, specified that 78,000 out 326,000 buildings in Dhaka are vulnerable to collapse, which also shows that official building codes have not been followed properly. Moreover, the Building Vulnerability Assessment of Dhaka, Chittagong, and Sylhet city corporation area shows gaps in implementation of

BNBC; for instance, there are guidelines in the building code for bar bending, but not practiced during the construction. The assessment also identified the vulnerability factors in three cities (CDMP 2009), namely, the presence of soft story in buildings (53 % in Dhaka, 23 % in Chittagong, and 14 % in Sylhet), heavy overhangs in buildings (41 % in Dhaka, 36 % in Chittagong, and 39 % in Sylhet), and short column in buildings (34 % in Dhaka, 15 % in Chittagong, and 15 % in Sylhet). Furthermore, Urban DRR Framework Report shows that in some areas, less than 10 % of buildings only follow the official building codes (Shaw 2014).

9.4.2.3 Inadequate Building Code to Address Climate Change

Climate-resilient buildings are considered as the most adequate in dealing with climate change impacts. Islam and Hossain (2013) analyzed the BNBC standards and found that several sections of the code, including open space within a plot, landscaping, rain loads, the requirements of building to flood-prone areas, and loads due to flood and surge, among others, are inadequate to address climate change impacts in Bangladesh. For example, several modern buildings developed as per the BNBC standards in southern and northeastern part of Bangladesh are inadequate to deal with the current level precipitation. Moreover, the current design to deal with roof drainage water in modern buildings has created huge wastage of rainwater and enormous pressure to the sewerage system due to inadequate drainage capacity to deal with water runoff (Islam and Hossain 2013). A number of strategies, such as rainwater harvesting and storage from roofs or other surface for future use and gray water storing which can be recycled and used for irrigation or toilet flushing, are used now in climate-resilient buildings (Islam and Hossain 2013; Shaw et al. 2007). Moreover, such strategies also contribute in fulfilling water demand and reducing the water runoff; for instance, the Red Kite House building, Wallingford constructed, uses a harvesting system to collect rainwater from the roof for reuse within the building (Shaw et al. 2007). The building satisfies 40 % of the building's annual water demand, and the drainage system is designed to reduce the impact of runoff on river systems (Shaw et al. 2007). Thus, while revising BNBC standard, rainwater harvesting system should be part of building code to deal with climate change.

9.4.2.4 Slums in Hazard-Prone Areas

In the absence of proper allocation of land and lack of proper access to basic infrastructure in urban areas from the Government of Bangladesh (GoB), the rural-urban migrant workers have no choice but to live in slums. Flooding and subsequent water logging are very common in Dhaka, but mostly affected are slums that have been grown on hazard-prone land (or low-lying terrain). Moreover, Shaw (2014) noted that almost 30 % of Dhaka population inhabits in slums that are located on the water's edge and exposed to flooding, waterlogging, and water-related diseases. In other words, such kind of land use allocation to slums has significantly increased inhabitants' vulnerability to floods.

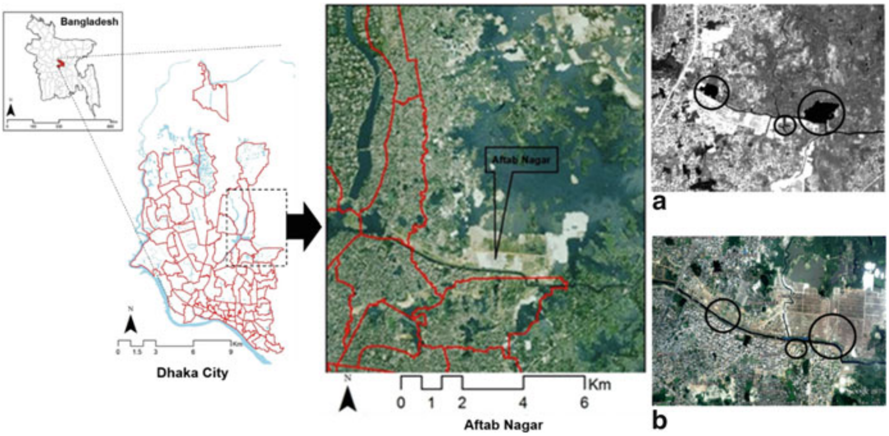

Fig. 9.2 Map of Dhaka City showing Aftab Nagar (*middle*) and its water bodies' situation in 1996 and 2010, respectively, (on *right*) (**a**) Image showing water bodies (in *black circles*) in Aftabnagar Residential Area in 1996. (**b**) Image showing disappearance of water bodies (in *black circles*) in Aftabnagar Residential Area in 2010 (Source: Government of Bangladesh and Dhaka North and South City Corporation n.d.)

9.4.2.5 Indiscriminate Earth Fillings in Urban Areas: The Case of Aftab Nagar, North Dhaka

The indiscriminate earth fillings in low-lying areas along the river can bring severe environmental problems, including waterlogging, liquidation, and disappearance of biological resources, among others. Since 2010, Aftab Nagar, North Dhaka (Fig. 9.2), is also facing similar environmental problems as a result of indiscriminate earth fillings by the housing estate projects carried out over a decade.

Aftab Nagar is a low-lying area, which is situated along the Balu River, which often brings seasonal flood during monsoon. In 1988, after a major devastating flood, the government planned to construct a 30-km-long road cum embankment along the western bank of Balu River. Simultaneously, 19 housing projects were also initiated, and five of them have been partially implemented by indiscriminate earth fillings in low-lying areas that resulted in the disappearance of natural drain, which originates from Balu, passes through Badda and Noadda, and connects to Begunbari Khal, one km to the West of Rampura Bridge in 1996. A large portion of water bodies has also disappeared at the same time as shown in Fig. 9.2a, b.

Moreover, construction of such housing projects on the reclaim lands can have severe earthquake liquidation effects in future. For instance, a comprehensive study by Comprehensive Disaster Management Program I (CDPM I) on Earthquake Liquefaction Susceptibility of Dhaka City (CDMP 2009) indicates that the eastern part of the city falls below the range of high to very high liquefaction susceptibility, which means that the housing projects that are implemented have already increased inhabitants' risks to earthquake liquidation. Moreover, the earthquake hazard maps for Dhaka city developed under CDMP have been already indicated eastern and southeastern part of Dhaka within high to very high liquidation susceptibility. Such information has been already recognized by the City Development Authority of Dhaka to be incorporated into land use plan preparation and implementation in future.

Similarly, under CDMP-II (2010–2015), the city corporation and municipalities, namely, Bogra, Dinajpur, Mymensingh, Rajshahi, Rangpur and Tangail, were identified as vulnerable to seismic risk and selected for carrying out seismic risk assessment with the technical consultation of ADPC. The assessment developed different kinds of exposure and scenario maps, which can assist decision-makers, including land use planners of UDD to understand the seismic risks in their land use planning areas. Recognizing the significance of such information, UDD decided to upgrade its conventional approach of land use planning by undertaking a research project on integrating DRR into land use planning with the technical support of ADPC.

9.5 Integration of Disaster Risk Reduction into Land Use Planning in Bangladesh: A Research Project

With few considerations of DRR into land use planning in Bangladesh, the conventional approach of land use plan preparation by UDD in the past has contributed significantly in urban risk. To address this, UDD decided to upgrade its conventional approach of land use planning by including DRR in the plan preparation. In 2012, UDD and ADPC jointly carried a research project on integration of DRR into land use planning in Bangladesh. The project builds on the assumption that an effective or ineffective land use plan can have a decisive influence on the development of a society over multiple generations, consistent with principles of sustainable development (UDD 2013). It aims at sustainable development for urban centers by making land use planning more risk inclusive through integration of DRR. Thus, it investigates the integration of DRR into physical/land use planning with a specific objective to promote risk assessment into land use plan preparation in Bangladesh.

9.5.1 Project Design

The research project achieved its objective by developing a framework for integrating DRR into land use planning in Bangladesh. It is developed through a project design, which consists of the technical advisory group (TAG) and technical team, reviews of literature on planning procedures, identifying shortcoming of the planning process, identification of steps for integrating DRR into land use planning (i.e., framework), and conducting an advisory dialogue (Fig. 9.3). The following section discusses project design in detail.

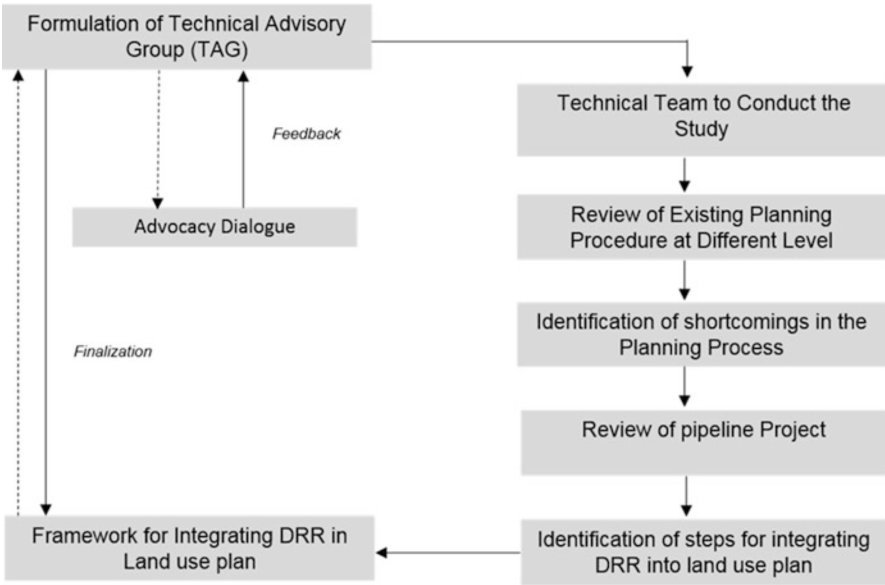

Fig. 9.3 Project design

A TAG was formed for providing overall technical guidance and recommendations for developing a framework for integrating DRR into the land use plan in Bangladesh (Fig. 9.3). The TWG comprised of a ten-member committee with the Director of UDD as chair. The other members of this committee include member representatives from the Ministry of Housing and Public Works; Planning Commission, Implementation, Monitoring and Evaluation Department; Bangladesh Institute of Planners; Bangladesh Fire Service and Civil Defense; Disaster Research Training and Management Center; and Dhaka University. The composition of the TAG was based on the involvement of the respective agencies at different levels of planning process currently being practiced. A technical team comprised of urban planner, geographer, sociologist, and geologist, who conducted the research project under the supervision of the Deputy Director (Research) of UDD with the guidance of TAG. The technical team conducted the research project by reviewing past relevant documents, technical papers, and consultation with the professionals related to the subject. In addition, it presented the findings to the TWG members to get their feedback and suggestions for next steps.

The technical team reviewed existing planning procedure in Bangladesh and Terms of References (TORs) from the context of DRR. Secondary research was carried out to understand details about the primary and secondary roles of UDD and to understand the existing methodology of preparing land use plans in the country at national, subnational, and local levels. It was found that the procedures that usually followed by UDD are not currently designed in a way that can address disaster risk in an efficient manner. Similarly, the technical team also reviewed the planning process and identified the shortcoming. To formulate, upgrade, and coordinate three-tiered planning packages (i.e., Structure Plan, Urban Area Plan, and DAP), the UDD utilizes set guidelines/planning processes for the preparation of a physical plan/land use plan in the country. The project found that DRR is indirectly dealt through existing guidelines/planning processes. Finally, the technical team also reviewed the pipeline projects of UDD, and it was suggested to undertake DRR related study at the Structure Plan level, such as hydrology and environment, environmental studies, hazard management, water resource management, and earthquake awareness.

9.5.2 Framework for Integrating DRR into Land Use Panning

Based on the technical team review and suggestions, several measures were suggested for integrating DRR into land use planning in Bangladesh. The measures include establishment of land use database and disaster database, analysis of land use and disaster database, formulation of land use matrix for compatible use and formulation of zoning regulations and development control, comprising of disaster risk criteria (i.e., hazard inventory and mapping), risk assessment, preparation of land use guidelines and standard, preparation of policy guidelines specific to disaster management and formulation of policies related to land use at different levels, formulation of disaster related policies, and awareness building and stakeholders' participation.

The draft framework for integrating DRR into land use planning was prepared through incorporating key suggested measures into different steps of land use planning preparation methodology in Bangladesh. The framework was later submitted to TAG for approval, and the framework (Fig. 9.4) was approved after advocacy and dialogue with stakeholders. It incorporates DRR into three key steps (first, second, and third steps) of preparing a land use plan (Fig. 9.4).

In the first step, DRR can be incorporated into the inception report by building awareness among stakeholders about disaster issues in the selected study area and by integrating DRR stakeholders into land use planning preparation. In the second step, DRR can be incorporated into the study area map with report by collecting disaster data from the concerned departments for hazard assessment and risk mapping purpose and by superimposing such data on the existing land use plan for mapping risk. In the third step, DRR can be incorporated into analysis by using risk maps for land use suitability analysis and guiding tool for the preparation of a land use plan.

The framework for integrating DRR into the methodology of land use plan preparation in Bangladesh (Fig. 9.4) is further supported by identifying the required data and sources for hazard assessment and risk mapping (Table 9.2). Table 9.2 shows fourteen types of hazard data required for land use planning in Bangladesh, which

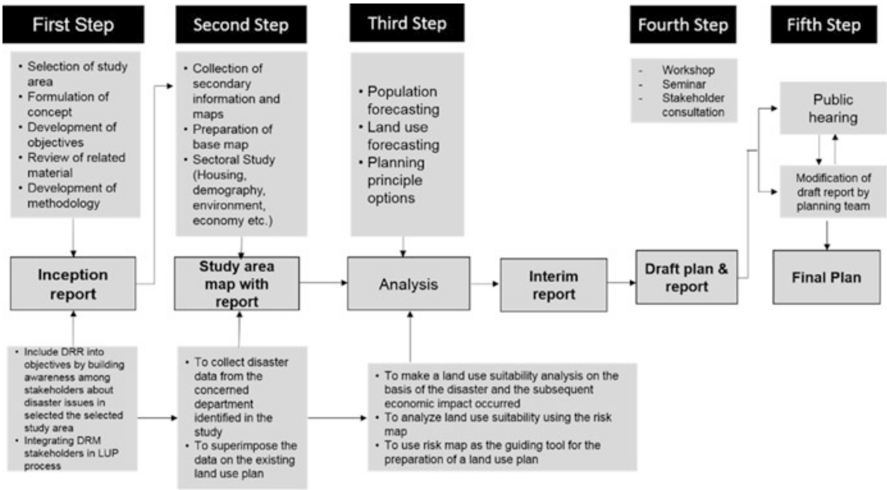

Fig. 9.4 Framework for integrating DRR into the methodology of land use plan preparation in Bangladesh (Adopted and modified from UDD 2013)

are identified through comprehensive discussions with stakeholders, disaster specialists, and academics (Table 9.2).

A list of 14 hazards, required data, and possible sources (Table 9.2) is very essential for land use planners in Bangladesh to understand the hazard profile of whole country including their own planning region. In addition to available sources, the planners can create a hazard profile of their own planning region by collecting required data through planning tools and integrating it into the second step of land use plan preparation methodology (Fig. 9.4). Moreover, land use planners can combine such hazard profile with the socioeconomic profile to understand the disaster risk of planning areas. Until now most of the planners in Bangladesh are unaware about the hazards of data requirement and sources; thus, such project's outcome is very significant for land use planners.

9.5.3 Project Recommendations

When the draft version of framework for integrating DRR into land use planning was presented in the dialogue meeting to the stakeholders for valuable suggestions, several rounds of brainstorming discussions took place on future improvements of land use planning in Bangladesh. In addition to finalization of the framework, specific recommendations for future improvements of integration of DRR into land use planning were adopted. The adopted recommendations include the revised framework (Fig. 9.4) which should be followed in the preparation of land use planning; DRR should be considered during the preparation of ToR for any land use planning;

Table 9.2 Hazard data required for land use/physical plans in Bangladesh

Type of hazards	Required data	Sources[a]
Flood	River system, elevation data, case study/history, types of flood, intensity, return period, damage information	BWDB, RRI, SoB
Cyclone and storm surge	Case study/history/cyclone path, indigenous knowledge, damage data, tidal wave height, wind speed	BMD, DMB
Tornado	Case study/history, indigenous knowledge, damage data, wind speed	DMB
Riverbank erosion	Case study/history, erosion-prone area, deforestation	IWM, CEGIS, DoF
Drought	Groundwater level, river system, rainfall, temperature, deforestation, water resources infrastructure	BWDB, DPHE, BMD
Earthquake	Seismic zone data, fault lines, vulnerable structures, liquidation/ subsidence, magnitude of earthquake, historical event, utility and lifeline, safety and security, medical facilities	DMB, GSB, BMD, CDMP
Arsenic contamination	Accepted level of arsenic, affected population, alternative drinking water sources, arsenic-prone area, availability of potable water	DPHE, DoE
Salinity intrusion	Shrimp cultivation, sea level rise, tsunami, tidal surge, depletion of groundwater level	DoE, SoB, BMD
Tsunami	Earthquake, volcanic eruption	GSB
Fire hazard	History/occurrence, vulnerable sources, road network for relief and rescue, water hydrant location/water bodies, medical facilities and safety	Fire service, civil defense, city corporation, development authorities
Infrastructure collapse	Vulnerable structures, soil condition, building code application	City corporations/municipalities, BRI
Landslide	Rainfall intensity, earthquake history, earthquake/hill cutting, settlements, deforestation	GSB, DoF, development authorities
Waterlogging	In-filling of waterways, drainage system, rainfall, flash flood, tidal surge, cyclone	City corporations/municipalities, WASA, BWDB
Groundwater depletion	Water pumping, pump house location, drawdown data	BWDB, DPHE, WASA

Source: Adopted and modified from UDD (2013)

[a]*BMD* Bangladesh Meteorological Department, *BWDB* Bangladesh Water Development Board, *BRI* Basic Rights Initiative, *CDMP* Comprehensive Disaster Management Programme, *CEGIS* Center for Environmental and Geographic Information Services, *DoE* Department of Environment, *DoF* Department of Fisheries, *DMB* Disaster Management Bureau, *DPHE* Department of Public Health Engineering, *GSB* Geological Survey of Bangladesh, *IWM* Institute of Water Modeling, *RRI* River Research Institute, *SoB* Survey of Bangladesh, *WASA* Water Supply & Sewerage Authority

UDD capacity should be strengthened in the area of DRR as well as upgrading of organogram and recruitment rules, inclusion of cadre service, etc.; professional planners should be trained in the field of DRR integration in land use planning; and DRR factor issues should be integrated in the land use planning in the urban and regional planning and land use management act (UDD 2013). Moreover, some of the recommendations were successfully applied in the land use planning in Bangladesh; for example, several projects under Mymensingh Strategic Development Plan (MSDP 2011–2031)—Redesign of Mymensingh Central Railway Station Area as a Transportation Hub, Riverfront Development as a Dream Place of Shilpacharya Jainul Abedin, Understanding the dynamics of Shambhuganj Bazaar Area and its Revitalization, Amusement in a Char: Proposed Leisure and Recreational Facilities in Mymensingh, and Open Space Adaptation in Disaster management: Designing Recreational Facilities and Open Spaces in Mymensingh City and their Possible Utilization in Disaster Management Program—have incorporated DRR into methodology section. Similarly, when ToRs were developed for MSDP (2011–2031), the responsibilities of individual consultants included DRR consideration; for example, the responsibility of a geologist related to DRR includes to review BNBC and synchronize the provisions made against seismic risk with the land use planning and to make recommendations on seismic risk in the study area.

9.5.4 Discussion

The project investigated the integration of DRR into land use planning and proposed the revised framework for integrating DRR into land use plan preparation in Bangladesh. It further promoted hazard assessment as well as risk mapping by identifying hazard data requirement and relevant sources for land use/physical plan in the country. The success of preparing DRR-inclusive land use plan depends upon how well the project outcomes as well as key recommendations are successfully implemented. In Bangladesh, all urban areas have the right to prepare their own land use plan, supported by the act and ordinance (Rahman and Islam 2013). Thus, all the development authorities and municipalities have autonomous power to prepare their own land use plan (Rahman and Islam 2013), which means that if they are capable enough, they can successfully prepare DRR-inclusive land use plan by implementing project outcomes. However, urban authorities and municipalities are suffering from deficiencies in their autonomous power. For example, in practice, development authorities are suffering from much interference of the central ministry, low overall capacity due to the fact that very few technical people prepare land use plans, and financial dependence on central government for allocation of funds, among others (Rahman and Islam 2013). All these issues show a threat to their autonomous power. In case of municipalities, although they have autonomous power to prepare land use plans, in reality their situation is worse than the urban authorities. For instance, municipalities are suffering from no setup for planners to prepare their own land use plan, with no financial and technical capacity (Rahman and Islam 2013). Such issues have been taken cared of by LGED who prepares land use plans for municipalities through private consultants. Unfortunately, the consultants appointed by LGED have common TORs, which hardly consider the needs of different municipalities. Thus, local needs of different municipalities are not considered and public participation is questioned under centralized planning approach (Rahman and Islam 2013). Finally, land use plans prepared for municipalities with such kind of setup are hardly accepted by the people and face implementation issues.

For successfully preparing DRR-inclusive land use plan by implementing the project outcomes, the capacity of both urban planners and local governments should be enhanced. For example, to prepare DRR-inclusive land use plan, it is a must that urban planners from municipalities and urban development authorities are trained on "how to" incorporate or apply DRR into the methodology of land use plan preparation (Fig. 9.4). Recently, in this direction, a 2-day training workshop on the "Handbook on DRR Integration into Urban and Land Use Planning in Upazilas and Municipalities in Bangladesh" was organized on tenth and 11th of June 2015 by UDD and ADPC. Over 30 urban planners from municipalities, urban authorities, and consulting firms participated in the workshop. The workshop provided training guidance on the draft handbook, which aims to assist or help planners (i) to understand the role of hazard and risk data and information during the planning process and how to manage and reduce risk through land use planning and (ii) to provide relevant disaster risk information to be incorporated into the land use plan preparation. The draft handbook was later disseminated to workshop participants for their comments and feedback for finalization. It is yet to see how well such handbook is utilized by urban planners for integrating DRR into land use plan preparation. With regard to capacity building of local governments, they should be empowered with full autonomy to prepare their own land use plan, and development authority could integrate these plans. The full autonomy should be supported in a decentralized manner, which means that they are also assigned with different powers as discussed in Sect. 9.3.3, and should be able to incorporate DRR into land use plan preparation as well as implementation.

In general, the Government of Bangladesh should promote the efficiency, equity and acceptability, and sustainability in the land use planning environment. For instance, in practice, the land use planning in Bangladesh should aim at sustainability balancing social, economic, and environment needs, based on stakeholder differentiation and gender sensitivity; promote civic engagement; integrate bottom-up aspects with top-down aspects, based on interdisciplinary cooperation that requires sector coordination; relate to spaces and places; link to financial planning; be implementation oriented; require transparency; and lead to an improvement in the capacity of stakeholders (GIZ 2011). Such land use planning environment will create an enabling environment for integrating DRR into the land use planning process in Bangladesh.

Finally, the project also consists of a limitation, particularly climate change issue is not considered directly; however, it has considered that issue indirectly by including climate-related disasters in the DRR. In addition, the main focus of the project was on the DRR integration into land use plan preparation aspect, but not on the implementation, monitoring, and evaluation elements (Fig. 9.2).

9.6 Conclusions and Way Forward

Achieving sustainable development in urban areas by making land use planning more risk inclusive is most important in dealing with increasing climate and disaster risks, which are further compounded by rapid urban growth in developing countries. However, while developing and implementing DRR-inclusive land use planning approach, most of the common issues that are faced include affected communities not allowed to participate in decision-making in planning, poor households in informal settlements who are excluded during public investments for risk reduction, and finally local government institutions which are disempowered to undertake preparation of land use plan for their administrative boundaries. It also means that the prime objectives of DRR-inclusive land use planning to address or reduce the vulnerability of the most urban poor are not achieved but only able to address the risk of communities which are not highly exposed to disaster risk. In other words, if DRR-inclusive land use planning is not effective at the local level, it will fail to achieve the core objectives of DRR initiatives globally. Thus, for DRR-inclusive land use planning to be effective at local level, the common issues highlighted above must be addressed.

In order to address such issues, it is essential that the planning and urban development approach must not only involve citizens, community organizations, and other civil society groups but such groups are also supported by a new generation of mayors and civil servants (Satterthwaite 2011; UNISDR 2009). It has been noted in several examples that such approach allows low-income communities negotiating reasonably safe and well-located land, adapting rigid zoning and building standards to local needs and possibilities, upgrading vulnerable settlements in ways that reduce risks, and participating in planning and budgeting processes (Satterthwaite 2011; UNISDR 2009). In the case of Bangladesh, rural-urban migrants' community (Sect. 9.3.2.4) is increasing rapidly and contributing extensively in urban risk (Sect. 9.1). Such community must be engaged as key stakeholders in all stages of land use plan preparation (Fig. 9.4) and its implementation. Finally, the urban planning in Bangladesh should find a right mix of regulatory, financial, and other incentives for such community and reduce their vulnerability to natural hazards.

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Part III
Mountain Issues in Land Use

Chapter 10
Flood Disasters and Land Use Planning in Swat Valley, Eastern Hindu Kush

Atta-ur-Rahman, Farzana, Ghani Rahman, and Rajib Shaw

Abstract This chapter analyzes the flood disasters and effectiveness of land use planning and enforcement in Swat Valley, eastern Hindu Kush, north Pakistan. In Swat Valley, flooding is a recurrently occurring phenomenon. In upper reaches flash flood characteristics dominate, while downstream Madyan river flooding dominates the scene. Downstream Madyan, Swat River enters into a wide basin and braided into numerous channels. The meandering river is frequently changing its course. In Swat Valley, almost every year in summer, the peak discharge overflows the natural levees and in effect causes damages to scarce agricultural land, housing, and other sectors. While in certain areas, deep riverbank erosion is very active and engulfing the farmland and built-up areas. Primarily, the active floodplain of Swat River was a vast grazing land, but with passage of time, the increasing population has used it for cultivation and other developments without taking into consideration risk of floods. This in turn has enhanced the flood vulnerability to various developments. For centuries people lived within the valley of Swat River with the reality of flooding as a natural hazard and with the fact that it has a potential to cause damages to people and their belongings, but so for no attention has been given to land use regulation and zoning. Land use regulations have been widely used as a non-structural flood mitigation strategy in reducing exposure of people and their property. It was found from the analysis that frequent human encroachments onto the flood channel and absence of land use regulations have been identified as the major factors responsible for heavy flood losses. Looking into potential and challenges in land use planning, this is high time to undertake fluvial morphology and rainfall-runoff model for flood risk assessment and spatial land use planning.

Keywords Swat Valley • Land use • Flood • Damages • Regulation and enforcement

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10.1 Introduction

Like other parts of Pakistan, flood is also a serious and recurrent phenomenon in Swat Valley, eastern Hindu Kush (Rahman and Khan 2011). For centuries people live within the valley of Swat River with the reality of flooding as natural hazard (Khan 2003; Rome 2005). Historically, the unprecedented rainfall with heavy melting of snow, ice, and glaciers in the catchment area has always generated high flood peaks in the Swat River. Traditionally, the local inhabitants understand the fact that Swat River has the potential to cause damages to people and their belongings, but so far no attention has been given to land use regulations, zoning and enforcement (Rahman and Khan 2013). It is, therefore, in this chapter an attempt has been made to highlight the issue and mainstream land use regulations and zoning in disaster risk reduction (DRR) planning and policy making.

The flood risk mapping is a complex process, where detailed assessment, zonation and graphical representation of various elements at risk are identified and mapped. In order to find the extent of flood vulnerability, it requires in-depth assessment of exposure plus sensitivity minus adaptive capacity (Yusuf and Francisco 2009). The identification of most vulnerable areas would obviously help in preparation of field based flood mapping and zonation. While working on flood hazard mapping and zonation, the researcher needs to kept in mind both the intensity and frequency of flood hazard. Likewise, in assessing flood risk, the hazard and vulnerability assessment is a pre-requisite. Now-a-days, in Geo-informatics, overlay analysis is the most appropriate and widely used approach for zonation of flood hazard, vulnerability and risk. Risk and vulnerability require effective assessment for devising strategies, demarcating probabilities and enforcing zoning regulations. Generally, zonation process may either suggest change in land utilization, improvement and or abandonment of specific land use (Carter 2005; Kron 2007). In flood hazard zonation, the stress remains on accelerating advantages from the floodplain through minimizing flood damages (APFM 2007).

In Swat Valley, flood is the most recurrently occurring disaster. Almost every year Swat River is flooded due to heavy monsoonal rainfall and excessive melting of snow/ice and glaciers. As a consequence, it recurrently washed away developmental gains and other properties. On average, every third year, the Swat Valley is hit by heavy flood event and as a consequence causes heavy damages to life and property. The analysis reveals that frequent flood events have washed away entire villages, infrastructure, communication lines, standing crops, fruit trees, and livestock. During the past one decade (2005–2015), recurrent flooding has seriously disrupted the socio-economic and physical infrastructure.

The Swat Valley (the study area) roughly follows the district boundary. The total area of the district is ≈5337 km^2. In 2013, the estimated population of Swat District was 2.3 million, and it is growing at a rapid pace of 3 % per annum. According to population census 1998, the literacy ratio was 29 % with 14 % female and 43 % male. In the study area, winter is extremly cold in the headwater region with considerable snowfall, whereas monsoon rain occurs during summer. During field survey, it was found that frequent human encroachments onto the flood channel and the absence of land use regulations have been identified as major factors responsible for heavy flood losses. Looking into the potential challenges in land use planning, this is high time that the government should undertake study on fluvial morphology, rainfall-runoff modeling for flood risk assessment, and formulation of spatial land use regulation and enforcement.

District Swat is located in the eastern Hindu Kush region of northern Pakistan. Topographically, it is a mountainous area with bumpy land surface and high peaks ranging from 733 m in the south to approximately 5740 m above sea level in the north (Rahman and Khan 2013). Hindu Kush region comprises of a number of fertile valleys drained by rivers and streams. Swat Valley is one of them and famous for its scenic beauty and esthetic value. The valley is elongated with mountains running on both eastern and western sides, Whereas River Swat flows through the middle of this beautiful valley in north-south direction (Fig. 10.1). The eastern mountain forms the watershed between the Indus and river Swat, while the western mountains form the watershed of Swat and Panjkora rivers, which drain Dir valley of northern Khyber Pakhtunkhwa.

Swat Valley has highland climate with cool summer and cold winters. Snowfall usually occurs in the month of February and March. During winter and spring, snow is accumulated in the high mountains which later on become the source of river recharge in summer season. Likewise, summer rain begins in July and continue until September. The summer rain is quite enough to increase river runoff and increase snow melting in the catchment areas. Swat River has a complex drainage pattern. Many streams join the river from both the right and left banks and the main river Swat flows in south direction, and then it takes syntoxic right bend near Mingora. The peak discharge data reveals that in Swat River high-flow season starts in May and continue till the end of August. This high discharge in summer is attributed to heavy melting of snow/ice and glaciers in the headwater region and partly due to summer monsoonal rainfall, resulting into recurrent floods.

Globally land use planning has been marked as one of the effective non-structural mitigation strategies in reducing people exposure to flood hazard. In Swat Valley, the populations are frequently encroaching onto the active floodplain and in effect reducing the channel carrying capacity and multiplying the cost of flood damages. There is lack of land use planning and building codes to regulate the effective utilization of active floodplain.

10.2 The Study Area

Swat District roughly follows the boundary of Swat Valley. Geographically, the study area stretches between latitude 34° 34′ to 35° 55′ north and longitude 72° 08′ to 72° 50′ east (Fig. 10.1). Relatively, it is bounded on the north by district Chitral of Khyber Pakhtunkhwa and district Ghizer of Gilgit-Baltistan province, on the east by Kohistan and Shangla districts, on the south by districts of Buner and Malakand,

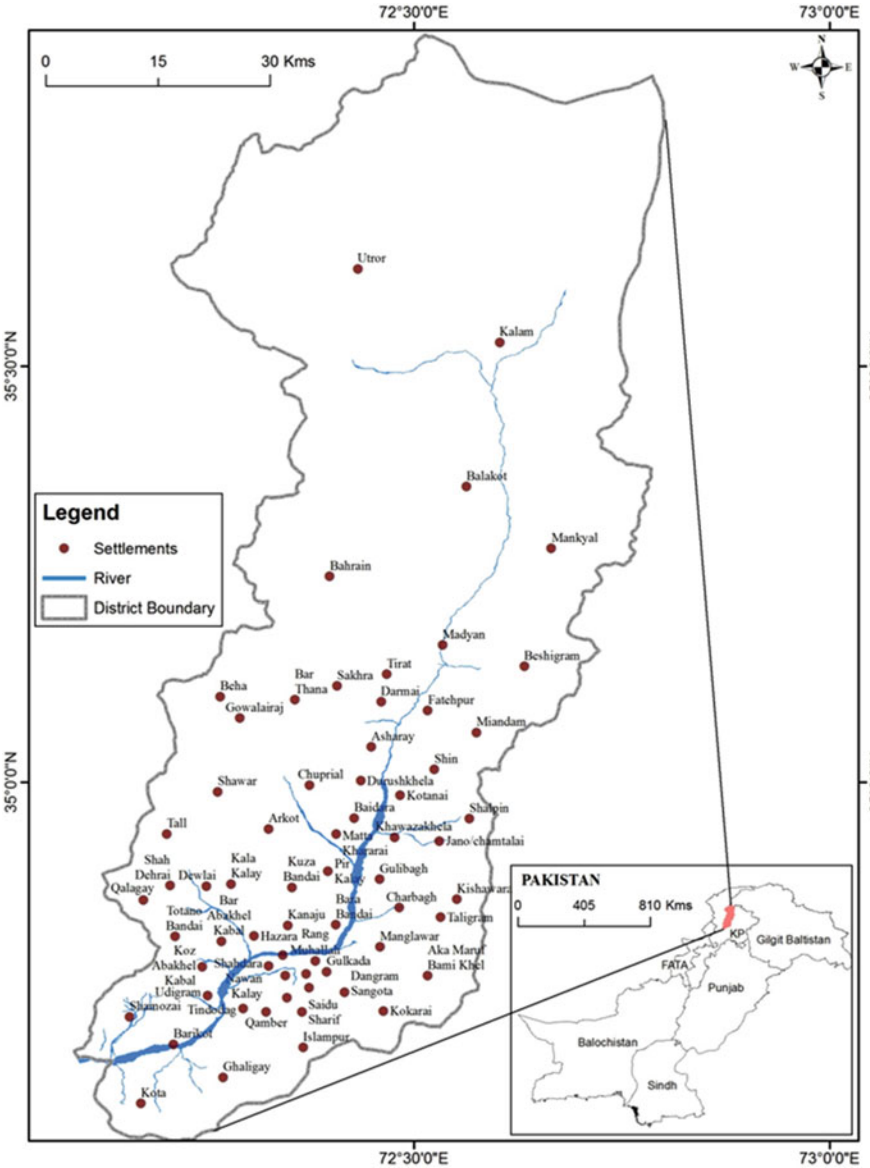

Fig. 10.1 Location map of Swat District

and on the west by Dir Upper and Dir Lower. The total reported area of the district is 5337 km^2. Mingora is the district headquarter. Swat Valley is also called eastern Switzerland. Most parts of the district has a short mild summer, while winter is long and cold especially in the upper mountainous area. Rainfall occurs both in summer and winter seasons. Summer monsoon rain occurs from July to September and

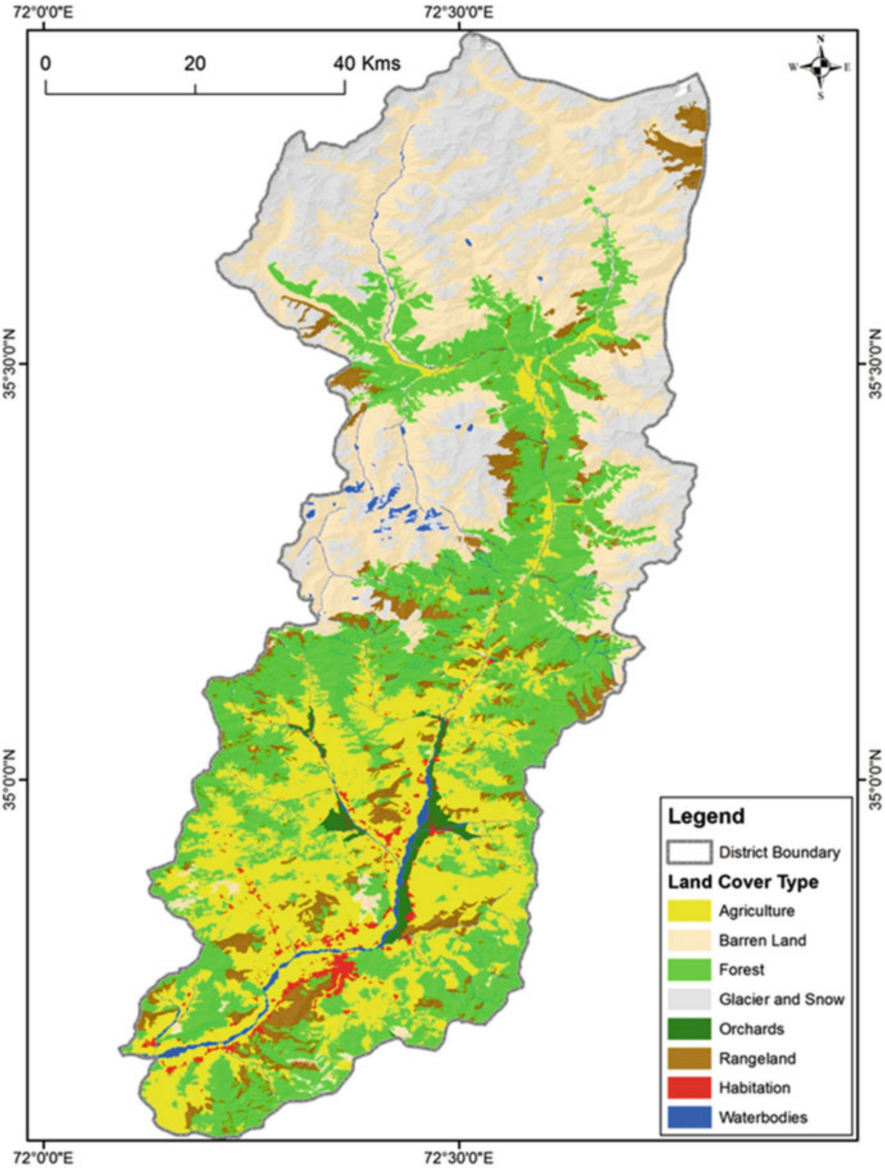

Fig. 10.2 Land use pattern in Swat District

combined with snow melting, which in effect increases the river discharge. In the study area, the economy is predominantly rural and agriculture is the main occupation. Most of the agriculture activities are carried out in the floodplain of Swat River. Out of the total reported area, only 19 % is cultivated, whereas 20 % is under forest cover (Fig. 10.2). According to the 1998 census, the population of the district was 1,257,600 with a population density of 236 persons per kilometer square.

Swat River along with its tributary streams drains the entire district. In the eastern Hindu Kush, Swat River has the largest drainage basin and fed by numerous small and large glaciers. The Swat Valley is elongated and Swat River divides the valley into two equal halves (Ali 1985) and flows through the middle of the valley. The general direction of Swat River is in north-south except a right bank bend at *Fizagat*. Swat River is the right bank tributary of Indus river system. It takes its origin from the northern extreme of Swat District. The two streams Gabral from Gabral glacier and Ushu from Ushu glacier confluence at Kalam, forming Swat River. Downstream Kalam, the river also receives several prominent perennial streams, namely, Harnoi, Deolai, and Daral. Swat River is recharged by rain, snow, and glaciers in the catchment area. The slope is from north to south. From Kalam to Mingora, the Swat River flows southward and then bend westward until it receives the major right hand tributary the Panjkora River. The united stream then flows southwestward and enters into Peshawar vale and joins the Kabul River at Nisatta. A Munda Headworks has been constructed on Swat River when it enters into Peshawar basin.

Swat District almost follows the boundary of Swat Valley (Rome 2007). The general direction of these mountains is north-south (Ali 1985). The valley is bounded on all sides by mountains except to the southwest, which gives an outlet to Swat River (Rahman and Khan 2011). The elevation of Swat Valley ranges from 733 m in the south to approximately 5740 m in the north. Swat District is divided into two major physiographic regions known as Swat-Kohistan and Swat proper. Swat-Kohistan includes the northern mountainous section of the district, while Swat proper is comparatively a low-lying area on either side of the river roughly starting from village Bagh-Dherai to as far as the southern tip of Swat District. Throughout the river course, it is narrow in the upper reaches varying from 35 to 40 m in Swat-Kohistan area, while it reaches to a maximum of 2000 m in Swat proper.

In Swat Valley, the climate is subtropical to temperate. Summers are hot in the lowland, warm in the upland, and cool at higher elevations in the extreme north of Swat Valley. Winter remains cold throughout the valley. There are three meteorological stations, which record weather data at Saidu Sharif (located at lowland in the south central), Malam Jabba (located at the hill station in the south), and Kalam (located at the north central). According to the Pakistan Meteorological Department, in Swat District June is the hottest month with a mean maximum temperature of 33 °C, while in January the temperature falls below dew point (Rahman and Dawood 2016). In the study region, the average annual precipitation ranges from 700 to 1600 mm distributed among three rain-bearing seasons of winter, spring, and summer. In winter season, precipitation mainly occurs due to western disturbance and it starts in December and lasts until the end of March. The higher elevations receive precipitation mostly in the form of snow.

The soil is fertile and suitable for crops, fruits, and vegetables. Wheat, rice and maize, are the chief crops grown in the district. Swat Valley is also a major source of fruits and vegetables. Apples, peaches, persimmons, plums, and apricots are the important fruits. The district is being divided into eight tehsils for administrative purpose. In this study, focus has been made on all eight tehsils.

10.3 Global Pattern of Land Use Zoning and Enforcement

The aim of land use zoning and regulations is to get maximum advantages of active floodplain with meagre damages and less investment on mitigation (Rahman and Khan 2013). The enforcement agency shall ensure that incompatible use of land in the floodplain may not continue and effectively implement the land use zoning and regulations in true spirit. In the floodplain, land use zoning is a non structural risk reduction strategy, to minimize and check the tendency of habitation in the vulnerable zones. In the floodplain management, land use zoning and enforcement of regulation is an effective mitigation strategy through minimizing population density, control over inappropriate use, and effective enforcement of building codes, designation of evacuation routes and replacement of structures that halt the laminar flow. As a preparedness strategy, the flood vulnerable countries in general and Pakistan in particular shall carryout hydrological modelling in a changing climate scenario for effective floodplain zonation and mapping. In Pakistan, the ministry of water and power through federal flood commission has started development of floodplain zoning and regulations in late 1980s but till date no priority has been given to finalize and enforce.

Globally, various land use policies were adopted to regulate land utilization (Tariq and Giesen 2012). It is the job of the local planning authority to allocate the land to development keeping in view that proper flood risk assessments have been carried out, and in some cases it allows developers to construct their infra-structure within the flood prone areas. In certain cases, the already established land use regulations are not respected in true spirit. Di-Martire et al. (2012) highlighted the case of Campania, where population increase has horizontally expanded the urban boundaries and eventually encroached over the flood risk zones.

Land use policies and zoning system is one of the key strategies in reducing exposure and underlying risk factors. Ministers at the fifth AMCDRR in Yogyakarta call on disaster managers and practitioners to enhance capacities and legislative coverage, to infuse and encourage DRR in land use planning at national, regional and local government level (UNISDR Asia and Pacific 2012). In this perspective, so far numerous countries have prepared, enacted and adopted legislative mechanism to enforce land use regulations and building bye-laws for enhancing disaster resilience against the unforeseen events, but it is not that productive due to poor capabilities of its operationalization. In Indonesia, the major challenge in addition to overlapping regulations is poor enforcement, and the efforts to enforce these regulatory and policy instruments have not been so successful. In Afghanistan, limited finances is one of the major reasons behind the poor enforcement of building regulations and resilient structures (HFA National Progress Report 2013).

The physical development and encroachments onto the active floodplain have increased the human exposure to flood risk. So far flood risk assessment and mapping have not been carried out to designate risk-sensitive zoning and enforcement. The Government of Pakistan recognises that there is absence of risk sensitive land use zoning and regulations for coastal areas, floodplain and mountainous territory (GoP 2012). Similarly, in Turkey construction is undertaken without taking into consideration the building codes (Balamir 2013). Nevertheless, risk communication to the vulnerable community would increase the probability of implementation process.

10.4 Building Codes and Its Implementation in Pakistan

It is the state's responsibility to periodically monitor the infra-structural development in the vulnerable areas and to safeguard that hazard-resilient techniques have been adopted. However, enhancing community awareness in hazard-prone areas is also an effective way of DRR and to follow the approved building codes in structures. The National Housing Authority has already prepared building guidelines for house construction in vulnerable areas. In order to prepare building codes for hazard-prone areas, the Ministry of Housing and Works (MoHW) has developed seismic zone map during the process of formulation of building codes in 2007. According to MoHW, to promote resilient structures in residential areas, the national and local government has been made responsible to guide relevant agencies/organizations to follow building codes and standards.

The Ministry of Housing and Works is responsible for collecting and disclosing information related to earthquake resistance of buildings to show current conditions and expedite efforts in the areas designated to promote disaster mitigation. On the other hand, the existing city governments are not in a position to effectively enforce building bye-laws. Even a city like Quetta, which was devastated by an earthquake in 1935, does not follow safe construction practices. The 1935 Quetta earthquake has ruined the city and since then Quetta building codes are enacted but the developers and urban authority poorly follow bye-laws (Rahman and Shaw 2015). The Quetta building codes include the list of public facilities with results of the building diagnosis, progress of diagnosis, and building strengthening. To ensure strict implementation, the local planning authorities were assigned a task to strictly follow the building codes and secure buildings against disasters.

In this regard, preparation of inventory with specifications need to be utilized. It may be more effective to develop sample house designs, multistorey buildings, and other structures as safe and resilient structures in hazard-prone localities (Rahman and Shaw 2015).

The implementation of building bye-laws is one of the long-term sustainable solution in minimizing impacts of hazards. While infusing disaster risk reduction, building bye-laws should be made mandatory in all new developments and gradual replacement of non-resilient structures by risk-sensitive ones.

10.5 Who Will Formulate Land Use Regulations?

The National Disaster Management Authority should devise land use planning and zoning regulations, and subsequently implement through respective provincial/regional and district disaster management authorities. In order to minimize industrial risk, the ministry of Industries should prepare safety regulations for all types of industrial units and also regularly monitor its enforcement. Similarly, the urban administration should strictly implement building bye-laws, land use zoning and regulations, as the city authorities have institutional capacity as against the rural set-up. Similarly, allocation of financial resources to promote safer construction practices. Likewise, to enhance awareness, enforce pilot programs on risk-sensitive construction in vulnerable areas.

10.6 Land Use/Land Cover Pattern in Swat Valley

In Swat, traditionally, the land ownership is rare of its nature. During the Yousafzai administration in 1600 AD, a unique system of land tenure and ownership called *wesh*/*Garzinda wesh* (mobile allotment of land) was established. In this land tenure system, lands were allotted to main tribe for a period of 5 years by making lottery (Rome 2005). This system has left worst impacts on land development and agriculture improvement. Due to the lack of land ownership, people invest very little to increase the land productivity of a temporary landholding. After 5 years, almost every reallotment resulted into land disputes. The local population once get productive agricultural land was never been ready to shift to less fertile locality. This system has always triggered conflicts and disputes among the local tribes. This system worked until the late 1930s. This system was abolished in 60's, where after a wide range of agriculture reforms and development was occurred. The new system has decisive influence on the development of societies in this mountainous region. Land utilization in appropriate way has resulted into high agricultural production and economic development. With the passage of time, fruit orchard was planted, new crop varieties were introduced, and thus application of chemical fertilizer and other agricultural inputs begun. Presently, fruits are produced and supplied to rest of the country markets.

In Swat District, land utilization varies from area to area depending on physical and socio-economic characteristics (Fig. 10.2). Being a mountainous area, the ratio of plain area is comparatively less. In terms of agricultural return, the most valuable and productive land is located in the floodplain of Swat River. Since the 1981 population census, the encroachment trend toward the floodplain is very rapid. Such land is largely utilized for agriculture, housing, and other infrastructural developments. It is a poor section of the community who prefers to live close to the river with high flood vulnerability as there is no other option but to purchase cheap land and start living in proximity to river with absolutely no resilience and coping capacity.

In Swat Valley, one of the recent studies on change in land use over the past four decades indicates drastic changes (Qasim et al. 2011). In the union council of Kalam, over 30 % of forest cover decreased, out of which 11.4 % deforested area is allocated to agriculture. Similarly, in Malam Jabba agro-forest zone, over half of the forest cover reduced during the past four decades and the same degraded land is allocated to farmland. However, in Barikot region, almost 32 % of forest cover has been reduced over a period of 40 years. Most of deforestation is attributed to extension in agriculture and built-up area, where built-up area increased to 161 %. In the same area, 129 % farmland also expanded at the cost of degraded forest cover (Qasim et al. 2011).

10.7 Human Encroachment and Flood Factors in Swat Valley

River Swat is an active geomorphic agent and it performs the function of erosion, transportation, and deposition of load. The river picks up the sediments and deposit it, where the condition gets favorable. Such heavy influx of sediment deposition in the drainage system is reducing its conveyance capacity. During high discharge, the water overflows the natural levees, resulting into flood and it is active floodplain of river Swat, which has the capability to attract and support population. In Swat Valley, the floodplain is intensively utilized for agriculture, settlement, and other infrastructural purposes.

Forests are vital for the economic development of a country (Khan 2003). According to the state of the world's forest report 2011, only 2 % of the area of Pakistan is under forest cover, and out of the total forest cover, 31 % is located in the province of Khyber Pakhtunkhwa and it is mostly in the districts of Swat and Shangla (Haeusler et al. 2000). In Swat Valley, a large proportion of rural population depends on the forest and other natural resources (Khan and Khan 2009). The land use/land cover data reveals that in Pakistan the state of forest cover is disperse and disappointing (Qasim et al. 2011).

The official records state that there is gradual increase in forest cover due to awareness and afforestation efforts, but the independent source negates this fact (Qasim et al. 2011), and the same is true for Swat District as well. However, deforestation and overexploitation of natural resources is an anguish phenomenon. Since the merging of Swat state (1969) with Pakistan, the forest resources in Swat were ruthlessly cut down (Rome 2005; Khan and Khan 2009). Since 1969, 27 % of the forest cover has been cleared for timber, settlement extension, infrastructure, and agriculture expansion (Qamer et al. 2012). In the study area, emphasis has been given to infrastructure and economic development neglecting the ecological perspective of resource exploitation, which holds numerous threats. Since 2001, the rate of forest degradation is 0.86 % per year (Qamer et al. 2012). In Kalam and

Malam Jabba, the forest area has been transformed into agricultural land, while in the plain areas, forests are cleared for built-up area due to population pressure.

It has been observed that forest is mostly cleared in the catchment area of Swat River. In the study area, the massive destruction of forest cover has been blamed as one of the listed cause of the 2010 flood event (Rahman and Shaw 2014). According to the revenue department, in Swat District 75 % of the agriculture products were damaged by the flood in 2010. If the current trend of deforestation and overexploitation of natural resources continues, there will be increasing flood risk in the entire valley. Plants and trees have the potential to hold the soil and reduce surface runoff by increased ground absorption. That is why with every subsequent flood event, the extent of damages is escalating.

In Swat Valley, early constructions were made up of mud and stones. Roofs were built from wood panels and bushes covered with clay on the top. However, the front and backyards of the houses were bare soil mostly covered with vegetation. Such traditional construction has encouraged soil infiltration and reduced surface runoff, though these constructions were simple but unreliable in the rainy season. In the study area, it has been observed that concrete structures are rapidly occupying the floodplain and reducing the soil infiltration and enhancing the risk of high flood runoff.

In Swat District, Mingora is the main urban center and its population is increasing at a rapid pace. In proximity to Mingora City, the human encroachment onto the natural channel is a regular feature. During the field survey, it was observed that due to high land values, people are illegally encroaching into the natural channel and narrowing the natural course. Similarly, sewerage lines and solid wastes are directly disposed-off in these streams and further reduce its carrying capacity. Natural ground surface is changed to non-pervious artificial surface and reduces the surface water-holding capacity, and when heavy rainfall occurs, the water overflows the surface resulting into pluvial floods. In Mingora, Amankot cluster is the most vulnerable and frequently hit by floods. Amankot is a densely populated cluster and located at the foothill. Almost every heavy rainfall results into a flood in the low-lying areas.

Swat District is largely a mountainous area and such plain area has multiple occupations. With increasing population, human alteration of the floodplain has increased and changed the runoff generation process. Rapid infrastructural development in the floodplain is the major cause of reducing the carrying capacity of Swat River. Likewise, large-scale human development in the floodplain of Swat River, claiming the old river bed, is a serious intervention and offense. This is mainly due to the absence of land use regulations and enforcement, which has encouraged the vulnerable population to encroach and re-encroach onto the active floodplain of Swat River. Throughout the river course, at certain location the government has constructed marginal flood protective embankments to secure the settlement and farmland from the flood impacts.

In Swat Valley, several bridges have been constructed to increase accessibility and reduce remoteness. Usually bridges are constructed where river is found narrow. However, in few cases the channel has been narrowed by filling up and raising the floodplain at the cost of minimizing the channel carrying capacity. Khwazakhela and Ayub bridges at Kanju are the typical examples were washed away during the 2010 flood.

In the study area, the government has constructed marginal protective embankment to save agricultural land flood effects without taking into consideration its impact on the adjacent land resources. These embankments were built in such a manner that it narrows down the channel, and now a large portion of reclaimed active floodplain is encroached by the local population for housing and other developments. Recently, Qambar bypass road is constructed on the left bank of Swat River and largely occupied by commercial activities. During the 2010 flood event, the same area (Qambar bypass road) was heavily inundated. Due to lack of land use planning and regulation, the local population is frequently encroaching onto the channel without taking into consideration the flood risk.

10.8 Floods and Land Use Planning in Swat Valley

During the past decade (2005–2015), Swat District has experienced many natural disasters and human-induced conflicts leaving everlasting impacts on people, resources, and economy. Among the list of hazards, flood is being the most frequently occurring and more fatal. During the field survey and human perception and response data collection, it was observed that stress has always been made on a short-term structural flood risk reduction strategies over long-term sustainable non-structural approach. In Swat Valley, structural mitigation approach is not a viable solution while dealing with the flood hazard. However, the non-structural mitigation approaches are more effective and sustainable way of reducing flood risk.

In Swat Valley, the place where people construct their houses is also a challenge and increasing vulnerability. Mostly, the houses and roads are built in a location exposed to high flood risk. In the study area, the floodplain of Swat River has been illegally encroached over either by the local population or preferred for government infrastructure with a justification of low-cost land. In Swat valley, construction, new developments, and other built-up properties have been allowed all along the active river channel. In the eastern Hindu Kush region, the local community lacks access to flood-resilient buildings and construction material.

In the study area, land use zoning, regulation, and enforcement have been regarded as technically viable, economically feasible, and socially acceptable strategies in halting the flood losses. Nevertheless, in the past, very little attention has been given to non-structural strategies. In the process of land use zoning and enforcement, few steps are involved including vulnerability and risk assessments, floodplain mapping and zoning, and formulation of land use regulation and enforcement. In Pakistan, such kind of practice is not reported nor a regular feature of flood risk reduction approaches. This is need of the honor to develop land use regulation and mainstream the same as a flood risk reduction strategy.

In Swat Valley, stress has always been made on structural flood risk reduction strategies over long-term sustainable non-structural approach. It has been observed in the post-2010 flood that structural mitigation approach is not a viable solution while dealing with the flood hazard. However, the nonstructural risk reduction approaches are more effective and sustainable in minimizing the flood risk. In the study area, land use regulations and zoning is one of the technically viable, economically feasible, and socially acceptable approaches in minimizing the flood damages. In Swat Valley, traditionally very little attention has been given to non-structural mitigation. In the process of land use zoning and enforcement, few steps are involved including vulnerability and risk assessments, floodplain mapping and zoning, and formulation of land use regulation and enforcement. In Pakistan, such kind of practice is not reported and need to be mainstreamed in the flood management planning and policy.

In Swat District, land use planning and enforcement is the responsibility of irrigation department, who manages the channel area, whereas District/Tehsil Municipal Administration (D/TMA) is responsible for land use planning in towns and villages. Unfortunately, these departments have not yet undertaken any progress in land use planning and enforcement. Initially, these departments should formulate land use zonation and regulation to limit land utilization in the floodplain and promote disaster risk reduction. The irrigation department has identified limits for the active channel and streams, but the community is consistently encroaching to high flood risk zones without taking care of flooding. Even after the disastrous flood of 2010, the floodwater inundated and washed away all the encroachments throughout the active flood channel. During the post-flood 2010, a number of relief organizations have started interventions and partially compensated the flood victims in early recover, rehabilitation, and reconstruction. However, the community has reconstructed the already washed away buildings in the same location without taking care of past experiences. Similarly, new developments are still in progress in the form of houses, hotels, restaurants, etc. in the active floodplain of Swat River. But none of the government departments are giving any serious attention to this alarming issue.

10.9 Flood Hazard Zonation in Swat Valley

In Swat valley, flood risk may be minimized by changing function of land use or minimize the exposure to recurrent flood events. The land use related departments need to introduce reforms, devise and enforce land regulations through short and long-term stretegies.

In Swat Valley, flood risk mapping still needs to be prepared, and due attention may be given to minimize the flood impacts. A flood risk map is a graphical representation of flood level. Such maps have also risk categorization as high-, moderate-, and low-risk zones on the basis of potential damages to social, economic, and geophysical sectors. A large variety of application of flood risk maps are available in literature and practiced in several countries. Based on these maps, regulations are streamlines and subsequently implemented for flood risk reduction. In Swat Valley, the floodplain characteristics vary from place to place and region to region depending on the topography and hydrological factors. While demarcating flood risk zones, socioeconomic bound needs to be kept in mind. The field observation reveals that the floodplain dwellers are often attracted by the rivers and offer numerous opportunities.

Regulation for flood zoning needs to be prepared with high safety standard and major focus on getting more benefits from the floodplains rather than merely reducing flood damages. In order to effectively utilize the floodplain, a comprehensive approach is required for the establishment of flood zones parallel to the flood channel. While demarcating various flood zones, proper attention need to be given to past massive flood events and their extent. Contrary to this, sole reliance on prohibition is not a beneficial risk reduction approach.

In Swat Valley, to get a maximum benefit from the floodplain utilization, a rational flood hazard zonation need to be planned to secure minimum flood damages (Fig. 10.3). In this attempt, flood risk can be minimized by changing the functional characteristics of land use practices, which in turn reduce the susceptibility. Generally, in floodplain zoning, it suggests for modification or abandonment of land use. In the active floodplain of Swat River, land is mostly allocated to rice cultivation locally called as *Sholgara*. In terms of investment, the land utilized for rice would cost more as against grass/grazing land and fodder crops.

The utilization of flood risk zones needs to be utilized in a hierarchical order as one proceeds from active channel toward outskirt such as grassland, fodder and rice, etc. Throughout the Swat River course, the zones shall be elongated and narrow in the upper reaches with a steep topographic characteristic and gradually widen as one proceeds downstream from *Khawaza Khela*. For example, the high flood hazard zone is located close to the active channel and needs to be specified for river training with no other utilization. Similarly, the allocation of moderate flood hazard zone is next to high hazard zone. This is a productive land and needs to be specified for agriculture economic activities and would help in getting maximum benefit out of the zone with minimum structural and human casualties. With the same intention and application, the land utilization needs to be extended to next zones.

This is the liability of District/Tehsil Municipal Administration (D/TMA) to apply land use planning in floodplain management of Swat River. It is time that the Tehsil Municipal Administration may take notice of frequent encroachments onto the flood risk zones. Presently, a bypass road has been constructed on the left bank of Swat River to avoid heavy traffic passing through Mingora City and to avoid congestion and development toward the active river channel. Within a year a huge number of resorts and restaurants have been constructed along the bypass road in the active floodplain of Swat River. New constructions are in progress all along the banks of Swat River without taking care of floodplain regulations.

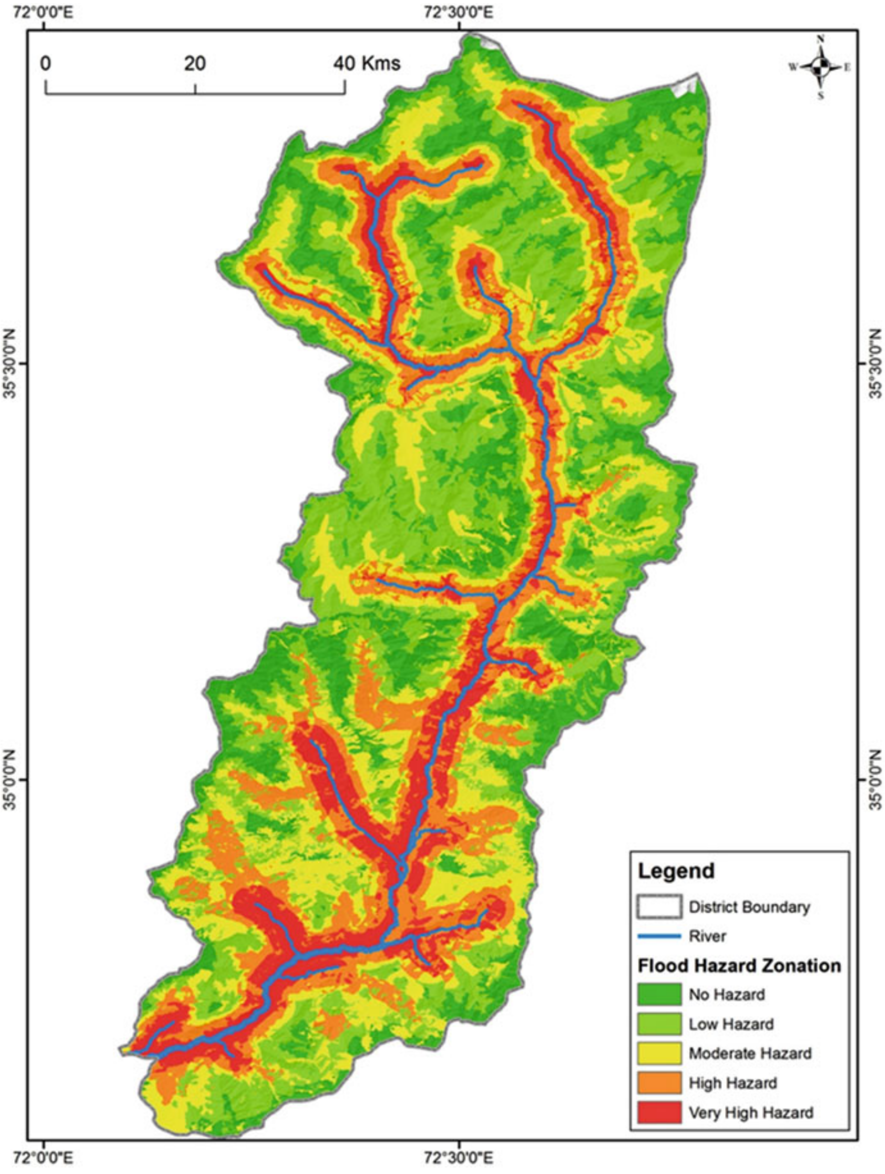

Fig. 10.3 Flood hazard zonation in Swat District

10.10 Conclusion

The analysis revealed that in the study area, flood hazard mapping is not yet prepared by the concerned government organization. It is therefore due attention be given to reduce the impacts of flood events. While managing floodplain, priority be given to get more benefits from the floodplain utilization and a rational flood hazard zones be made with little or no adversaries. It is need of the hour to undertake hydrological modeling, floodplain mapping, and zoning all along the Swat River system in a climate change scenario and to measure flood peaks through projected estimates. Similarly, promoting the use of flood risk information for effective land use planning and zoning programs is also one of the key strategies in disaster risk reduction. Floodplain zoning and management include legislation for land utilization, ban on new construction in the high flood hazard zone, removal of encroachment from the active floodplain of Swat River, and allocation of land to specific use with little or no damages. In addition to this, to enforce effective structural mitigation strategies in the flood-prone localities and also take into consideration integrated flood risk reduction plans. Allocation of funds to promote safer construction practices is another effective way of dealing with flood disasters. Likewise, to implement pilot programs on safer construction in flood-prone areas would help in enhancing awareness in the high-risk zones.

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Chapter 11
Guinsaugon, Leyte Landslide: Experience and Lessons in Land Use Policy

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Abstract Land use planning was an important issue revisited after the Guinsaugon, Leyte landslide in 2006. Without a national land use policy in the Philippines, effective planning and implementation of the comprehensive land use plan of local government units is still sought. This chapter examines the landslide disaster experience of Guinsaugon, Leyte, and its implications for land use policy specifically looking at the need to revisit land use policy and the importance of risk-sensitive land use planning and public participation in land use planning after a disaster. It also describes the land use planning process in the country including policies and relevant government agencies. The lessons of the disaster are expected to strengthen land use decisions in mountain regions in the country.

Keywords Leyte landslide • Land use policy • Comprehensive land use plan • Mountain hazards

11.1 Introduction

The importance of land use management in disaster risk reduction (DRR) cannot be overemphasized. Land use is critical in the development not only of urban areas and the built environment but also in the natural environment such as mountain, coast, and river system. Strategic land use planning is a critical tool in the mitigation and

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prevention of disasters. Emergency Management Australia (2002) suggests that land use planning can minimize risk in a number of ways including (i) prohibiting development in high-risk areas through zoning and overlay controls, (ii) limiting the types of development in high to moderate risk areas for recreation or other forms of public use reducing the potential impacts of natural hazard events, and (iii) applying appropriate development controls in moderate and lower risk areas such as minimum elevations, setbacks, and lot sizes, as well as maximum densities and site coverage.

The major drivers of land use changes are demographic conditions, development and the associated geographic specialization of economic activities, technology, political structure, attitudes, and values (Lambin and Geist 2007). Land use changes have major ecological repercussions at different biological scales. An understanding of the socioeconomic and biological aspects of land use decisions is therefore necessary to determine potential effects of land management strategies (Dale 1997).

11.1.1 Land Use and Mountain Hazards

Steep topography, remoteness, and variable climatic conditions make mountain regions highly vulnerable to multiple hazards and disasters (Mountain Partnership n.d.). Large-scale hazards present in the mountains include earthquakes, droughts, eruptions, and hurricanes, while mass movements of water, snow, ice, soil, and rock are among the small-scale hazards. In addition, there are hazards resulting from natural processes such as avalanches, debris flows, floods, landslides, rockfalls, and other mass movements of soil and rocks. These natural hazards can affect mountain areas by causing ecological damage and destruction to property as well as harming mountain communities (Zingari and Fiebiger 2002). Through appropriate land use management, vegetation, and protection, forests can play a critical role in reducing risks associated with mountain hazards. Among the identified mitigation functions of mountain forest and other vegetation on hillsides include (i) vegetation cover and root structure protect against erosion and increase slope stability by binding soil together thus preventing landslides; (ii) forests protect against rockfall and stabilize snow reducing the risk of avalanches (ProAct Network 2008); (iii) catchment forests, especially primary forests, reduce the risk of floods by increasing infiltration of rainfall and delaying peak floodwater flows, except when soils are fully saturated; and (iv) forests on watersheds are important for water recharge and purification, drought mitigation, and safeguarding drinking water supply for some of the world's major cities (Uy and Shaw 2012). Moreover, mountains are considered as early warning indicators of climate change. Land use practices thus play an important role in a sensitive and highly variable environment like the mountain. By preventing soil erosion and maintaining mountain meadows and forests, for example, people in downstream areas can be protected from landslides and flash floods (Kohler and Maselli 2012).

11.1.2 Land Use and Climate Change

According to Dale (1997), the impacts of land use can be viewed from the perspective of the effects of land use on climate change, on one hand, and the effects of human-induced climate change on land use, on the other. In the former, the effects of land use refer to the implications of land use change on atmospheric flux of CO_2 and its subsequent impact on climate and the alteration of climate change impacts through land management. Land surface patterns, such as marine and terrestrial ecosystems, have significant mitigation capacity, absorbing half of the anthropogenic emissions by acting as huge buffers between emissions and the warming caused by them and storing large amounts of carbon fixed in biomass, soils, and the oceans (CEEweb for Biodiversity 2012). Any change in these ecosystems will bring about a different response to climate change. In the latter, human activities can influence greenhouse effect through the release of greenhouse gases and can alter the distribution of ecosystems and their associated fluxes of energy thereby changing the patterns of carbon storage. As an example, land use decisions determine how forest areas will shrink or grow leading to deforestation and afforestation. In modulating ecosystem feedbacks to climate, deforestation is important for reasons that the amount of deforested area may change in response to climate change and will modify the extent and functioning of natural ecosystems thereby preventing some feedbacks or promoting others (Field et al. 2007). Planning for climate change, therefore, would necessitate the consideration of land use planning that reduces the future carbon impact of new developments and enhances resilience against climate-related hazards. For this, policies on climate change, disaster management, and land use planning need to be linked together to deal with both mitigation and adaptation measures (Bajracharya et al. 2011).

11.2 Land Use Planning in the Philippines

11.2.1 Policy Context

The Philippines does not have a national land use policy but is in the process of having one adopted. The proposed National Land Use Act (Republic Act 3091) seeks to (i) institutionalize land use and physical planning as mechanisms for identifying, determining, and evaluating appropriate land use and allocation patterns; (ii) rationalize the utilization, management, and development of land resources; and (iii) ensure optimum use of land resources consistent with the principle of sustainable development. Among its salient features include the (i) creation of a National Land Use Commission under the Office of the President; (ii) implementation of national base mapping and geohazard mapping programs; (iii) provisions for areas of concern such as agricultural lands, forest lands and watershed management, coastal zones, mineral lands, and energy resource lands; and (iv) provisions for the development of settlements, industrial areas, tourism and heritage areas, and infrastructure (Senate of the Philippines 2011). Presently, in the absence of a national policy, the 1991 Local Government Code, which gives local government units (LGUs) the power to regulate land use, serves as the land use and urban development strategy of the country (Corpuz 2013).

11.2.2 Government Agencies Relevant to Land Use Planning

The Housing and Land Use Regulatory Board (HLURB), National Economic and Development Authority (NEDA), Climate Change Commission (CCC), Department of Environment and Natural Resources (DENR), and Department of Interior and Local Government (DILG) are among the government agencies key to the implementation of land use activities in the country. The responsibilities of these agencies in land use management are discussed in the following.

Presidential Decree (PD) No. 933 and Executive Order (EO) No. 648 of 1981, as amended by EO No. 90 of 1986, empower the HLURB to review, evaluate, and approve or disapprove land use plans of cities and municipalities. In 1993, EO No. 72 devolves the powers of HLURB to review and approve the comprehensive land use plans (CLUPs) of component cities and municipalities to the province thereby establishing the Provincial Land Use Committee composed of the provincial planning and development coordinator as chairman, the provincial agriculturist, a non-government organization (NGO) representative, and representatives from the HLURB, DENR, Department of Agrarian Reform, Department of Trade and Industry, Department of Public Works and Highways, Department of Tourism, and DILG. HLURB, in its mandate of promulgating zoning and other land use control standards and guidelines, has developed the CLUP Guidebook: A guide to CLUP preparation. This guidebook consists of five volumes including CLUP preparation, sectoral studies in the CLUP preparation, data management in the CLUP preparation, planning strategically, and zoning ordinance. Supplemental guidelines have also been developed to mainstream climate and disaster risks in the CLUP. Trainings and workshops are being conducted to disseminate the guidebook and supplemental guidelines nationwide.

NEDA, the country's social and economic development planning and policy coordinating body, and its Regional Development Office through the National Land Use Committee which it chairs, adopted an action agenda in March 2006 that aims to contribute to the reduction of risks associated with disasters. The agenda seeks to put in place preventive measures such as (i) supporting mapping activities to characterize natural hazards in a specific area and delineating their geographic impact coverage, (ii) augmenting development and physical framework plans with analysis of hazard and potential risks, and (iii) enhancing capacity of LGUs in instituting DRR measures (NEDA et al. 2008). Toward this end, the Guidelines on Mainstreaming Disaster Risk Reduction in Subnational Development Land Use/Physical Planning were developed to direct DRR efforts in development planning processes. As a tool, the guidelines are useful in the following: (i) identifying areas that are highly restricted to human settlements and economic activities particularly those that (a) are highly prone to the adverse impacts of hazards; (b) need to lessen the effects of hazardous events, e.g., water retention areas, lahar-playing fields, and buffer zones; and (c) need to ensure effectiveness of response activities, e.g., escape routes and staging areas; (ii) highlighting the use of development criteria or indicators as measures to identify and describe vulnerability (or resilience) and their integration in the disaster risk management framework; (iii) making differentiated decisions on land uses which may involve specifying acceptable land uses based on the risk assessment results; (iv) developing disaster risk criteria in land use planning and zoning; and (v) identifying all other appropriate risk management decisions depending on the risk assessment (NEDA et al. 2008).

The CCC is the lead policy making body of the government tasked to coordinate, monitor, and evaluate climate change programs and ensure mainstreaming of climate change in national, local, and sectoral development plans. It developed the Climate and Disaster Risk Assessment methodology used to enrich the preparation process for a risk-sensitive CLUP. By integrating climate change adaptation (CCA) and DRR in the CLUP, sustainable development can be achieved through sound land use development. Specifically, it can inform and ensure that (i) the direction of spatial and sectoral development addresses current and future risks and vulnerabilities, (ii) the future development does not increase the risks and vulnerabilities of people and property, and (iii) the individual, community, and environmental resilience are promoted (HLURB et al. 2014).

DENR has a Mapping and Assessment Program implemented by the Mines and Geosciences Bureau (MGB), which seeks to identify areas in the country which are susceptible or vulnerable to various geologic hazards. The program focuses on (i) rapid assessment survey to generate geohazard maps that indicate areas prone to natural hazards such as landslides, flooding, and ground subsidence; (ii) printing and reproduction of maps, manuals, and information materials for public dissemination; and (iii) conduct of seminars and workshops for local government officials and public school teachers to increase awareness and preparedness on various natural hazards and to instruct the proper use of the geohazard maps. In addition, DENR, through its Forest Management Bureau, and LGUs, together with other government agencies, undertake forest land use planning as an integral activity of comprehensive land use planning for optimum and balanced use of natural resources to support growth and development at local, regional, and national levels (DENR and DILG 1998).

Lastly, the DILG is mandated to provide general supervision over LGUs. Accordingly, it is tasked to develop and scale up the capacities of LGUs, render performance oversight, and provide incentives to LGUs that excel and perform. It monitors the formulation and updating of local plans such as CLUPs, Comprehensive Development Plans (CDPs), and Provincial Development and Physical Framework Plans. Moreover, it supports enhancing LGU capacity on CCA, disaster risk reduction and management, and disaster preparedness through assessment, institutional capacity enhancement, and access to financing. It awards the annual Seal of Disaster Preparedness to LGUs exhibiting excellence in disaster preparedness.

11.2.3 Comprehensive Land Use Planning

In general, land use planning in the country has the following objectives: (i) promote the efficient utilization, acquisition, and disposition of land and ensure the highest and best use of land; (ii) direct, harmonize, and influence discussions and activities of the private and public sectors relative to the use and management of land; (iii) reconcile land use conflicts and proposals between and among individuals and private and government entities relative to the present and future need for land; (iv) promote desirable patterns of land uses to prevent wasteful development and minimize the cost of public infrastructure and utilities and other social services; and (v) conserve areas of ecological, aesthetic, historical, and cultural significance (HLURB 2006). It is considered a cost-effective and proactive approach in managing current and future risks by guiding the preparation of disaster and climate risk-sensitive local level plans (i.e., CDP, Local Development and Investment Plan, and Annual Investment Plan) and through inclusion of ecosystem management approaches (HLURB et al. 2014). The linkages among local level plans are depicted in Fig. 11.1.

One approach for governments to bring about wise decisions for disaster-prone areas is to mandate local governments to prepare comprehensive plans that are con-

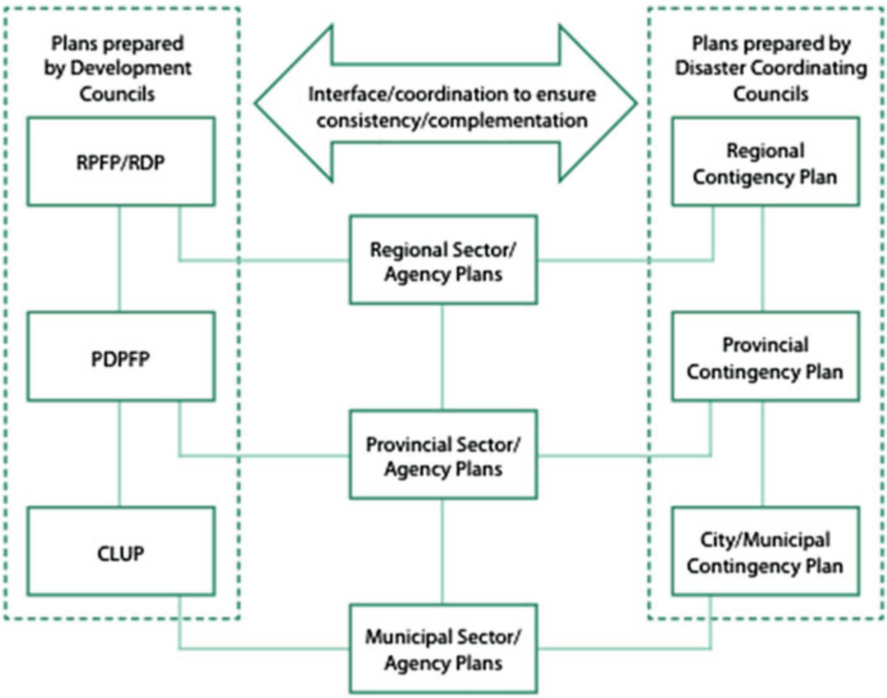

Fig. 11.1 Linkages among local level plans. (Source: NEDA et al. (2008)). Legend: RPFP/RDP-Regional Physical Framework Plan/Regional Development Plan

sistent with policies (Burby 2006). EO No. 72 of 1993 mandates LGUs to prepare and implement CLUPs in accordance with the land use planning and zoning standards and guidelines prescribed by HLURB. The CLUP process is a way of rationalizing the allocation and regulation of land resources through comprehensive and empirical analysis of social, economic, physical, environmental, political, and institutional elements in the city or municipality providing LGUs a basis in formulating development goals and objectives, designing alternatives, and determining appropriate actions through policies, strategies, programs, and projects. The CLUP usually covers a planning period of 10 years which may be reviewed every 3 years coinciding with the term of office of the mayor and other locally elected officials.

Supplemental guidelines have been developed for climate and disaster risk-sensitive CLUPs to minimize or prevent exposure and vulnerability of population, infrastructure, economic activities, and the environment to natural hazards and climate change (HLURB et al. 2014). Based on HLURB's CLUP Guidebook, the preparation of CLUP follows a 12-step process specifically (1) getting organized; (2) identifying stakeholders; (3) setting the vision; (4) analyzing the situation; (5) setting the goals and objectives; (6) establishing development thrust spatial strategies; (7) preparing the land use plan; (8) drafting of the zoning ordinance (ZO); (9) conducting the public hearing on the draft CLUP and ZO; (10) reviewing, adopting, and approving the CLUP and ZO; (11) implementing the CLUP and ZO; and (12) monitoring, reviewing, and evaluating the CLUP and ZO. This process, with guidance in incorporating climate and disaster risk considerations, is shown in Table 11.1.

Three sets of conditions must be met for a land use plan to have a positive and significant impact: technical merit, political mandate and organizational capability, and sufficient financial and other material resources (Corpuz 2013). Furthermore, Corpuz (2013) gives some reasons why land use policies and plans are not effective such as (i) supply bias and lack of consideration for demand; (ii) lack of interlocal/intermetro integration; (iii) use of outdated or inappropriate planning principles and design parameters; (iv) spatial equity vs social equity; (v) lack of disaster risk reduction provisions; and (iv) weak planning-implementation linkages and corruption. Indeed, some of the gaps identified in many of the LGUs by ASEP et al. (2014) are that CLUPs and ZOs are outdated or not implemented and geohazard assessment has not been integrated in residential and commercial zones.

11.3 The Guinsaugon, Leyte Landslide in 2006

11.3.1 Background of the Disaster

On February 17, 2006, a landslide occurred in Guinsaugon, one of the *barangays* (villages) in Saint Bernard, a fourth class rural municipality located in Southern Leyte, Philippines (Fig. 11.2). It was described as a 15-million-m^3 rockslide-debris avalanche from an approximately 700-m-high escarpment (Luzona et al. 2013). The

Table. 11.1 The 12-step process in comprehensive land use planning integrating disaster and climate risk concerns

<table>
<tr><td>Incorporate the conduct of the CDRA in the work and financial plan</td><td rowspan="5">Include local stakeholders and representatives from the hazard mapping agencies who will participate and assist in the CDRA</td><td rowspan="5">Fine-tuning vision description and success indicators based on the relevant findings from the CDRA</td><td>Enhanced understanding of climate and disaster risks affecting the locality</td><td>Specific indicators address current risks</td><td>Incorporate climate change adaptation and disaster risk reduction concerns in evaluating development threats and spatial strategy options</td></tr>
<tr><td rowspan="4">Organize key sectoral representatives who will participate in the CDRA</td><td>Priority decision areas based on risk inundation</td><td rowspan="4">Goals, objectives, and success indicators related in future planned disaster risk reduction and climate change adaptation</td><td rowspan="4">Ensuring selected development thrust and spatial strategies account for the future climate change scenario and its possible impacts to the severity and frequency of natural hazards</td></tr>
<tr><td>Policy interventions/options with emphasis in risk management options</td></tr>
<tr><td>Adjusted land demand to account for backlogs due to risk and vulnerabilities</td></tr>
<tr><td>Analysis of land supply and suitability based on climate change and possible impacts on the severity and frequency of natural hazards</td></tr>
<tr><td>Step 1
Organize</td><td>Step 2
Identify stakeholders</td><td>Step 3
Set the vision</td><td>Step 4
Analyze the situation</td><td>Step 5
Set the goals and objectives</td><td>Step 6
Establish development thrust and spatial strategies</td></tr>
<tr><td>Step 12
Monitor and evaluate the CLUP and ZO</td><td>Step 11
Implement the CLUP and ZO</td><td>Step 10
Review, adopt, and approve the CLUP and ZO</td><td>Step 9
Conduct public hearing</td><td>Step 8
Drafting the zoning ordinance</td><td>Step 7
Prepare the land use plan</td></tr>
</table>

Identification of risk reduction and climate change adaptation monitoring parameters and procedures	Strengthen the support institutional structures, systems, and procedures for enhancement and monitoring	Ensure that identified risk management options effectively address current risks and prevent future risks translated in the CLUP and ZO	Consultation with stakeholders on the accountability of proposed risk management options	Establishing hazard everyday zones and priority risk management zone districts	Climate and disaster risk-sensitive land use allocative/spatial location
PPAs impact monitoring and evaluation	Program and project assessment prioritization and development	Inviting representatives from agencies involved in DRR-CCA (i.e., hazard mapping agencies, Provincial DRRMO, Provincial CCC) during the review and approval process		Zoning regulations to reduce risks by applying risk reduction approaches such as density control, hazard-resistant building design standards, site development standards, and additional development requirements	Applying risk reduction measures, risk avoidance, migration, transfer, and situation in designing the land use scheme and land use policy development
	Budgetary support/ requirements			Consultation with hazard experts and stakeholders in the identification of zoning regulations	Menu of programs and projects for disaster risk reduction and climate change adaptation
	Information, education, and communication campaigns				
	Interface with other local level plans to implement DRR-CCA agenda				

Source: HLURB et al. (2014)

Fig. 11.2 Location of the municipality of Saint Bernard, Southern Leyte

area is identified as a geohazard zone because of fault lines traversing the mountain range in Guinsaugon and adjoining barangays (Felizardo et al. n.d). There are three tectonic plates that converge in Southern Leyte: the Philippine Sea plate, the Eurasian plate, and the Philippine Fault (Evans et al. 2007).

Guinsaugon and the surrounding *barangays* have steep mountains on the western part with many hills at the foot and flat terrain on the eastern section. Found along the western scarp of the Philippine Fault, Guinsaugon's geology is characterized as highly porous consisting of sandy clay embedded with loose rock materials and boulders with intense fracturing and weathering contributing to its instability and susceptibility to mass movements.

Continuous heavy rainfall totaling 571.2 mm from February 8 to 12, 2006 (Luzona et al. 2013), equivalent to almost 3 months of the area's average annual rainfall of 3,000 mm (PCIJ 2006), led to the failure of the 450-m-high rock slope that swept with a 6,400-m path into the densely populated Himbungao River valley. Apart from the excessive amount of rainfall, a 2.6-magnitude earthquake that occurred 21-km west of Guinsaugon on the same day and the deformation of the slope prior to the landslide are said to have triggered the rockslide-debris avalanche (Lagmay et al. 2008).

The landslide is the largest known sediment mass movement in the country that claimed 1,126 lives (Luna et al. 2011) and displaced approximately 19,000 residents (Luzona et al. 2013). The rockslide-debris avalanche occurred when a women's association in the municipality was holding its third anniversary celebration.

Women from other villages came to visit and join the annual festivity as well. After the search and retrieval operations, local authorities were able to retrieve 52 bodies, while 951 residents had been buried alive. Those who were buried alive included municipal officials, school teachers, and around 200–250 elementary school students attending morning classes (Luna et al. 2011; Evans et al. 2007). Had the disaster happened around lunch time (between 12:00 and 1:00 pm), there would have been more casualties including the municipal mayor, the council, and a busload of college students who were expected to arrive to celebrate with the women (Luna et al. 2011).

11.3.2 Post-disaster Land Use Actions

When the disaster struck, the Philippines' disaster management system was still governed by a reactive emergency response paradigm. As such, there was no disaster management office and rescue teams in place when the landslide happened. The disaster event was a catalyst to reviewing the municipality's land use plans. Subsequently, hazard risk assessments were undertaken at community level under a participatory land use and development planning program supported by the German government's international development agency (GTZ). It emphasized a bottom-up approach allowing community members to identify hazards and resources that can be used to address risks. Local leaders underwent trainings on mapping, global positioning system, perimeter survey, and formulation of development plans which they also passed on to community leaders and who, in turn, passed these to community members. Consequently, local residents were involved in the identification of hazard-prone areas and the preparation of local maps. Each *barangay* produced a community development plan that addresses its vulnerabilities and needs for recovery (Luna et al. 2011). Hazard assessments were also conducted by the Philippine Institute of Volcanology and Seismology, DENR, MGB, and CARE Philippines which revealed that 70 % of the total land area of Saint Bernard is highly vulnerable to various hazards (SCR 2010).

The affected population was relocated to another village, Magbagacay, as a result of this new planning process. Their new home, which the residents call New Guinsaugon, is far from the dangers of the mountains. The hazard risk assessments were also able to identify six other communities located in danger zones, thereby forcing these communities to move to the relocation sites. In the end, the municipal government established a disaster and emergency management office as well as integrated disaster risk management into development planning processes such as disaster-proofing development priorities in the Executive and Legislative Agenda and allocating local resources (i.e., Disaster Risk Reduction and Management Fund and Economic Development Fund) from emergency response to disaster preparedness, mitigation, and climate change adaptation activities. Specifically, the DRR activities included the following (SCR 2010):

1. Strengthening community capacities for disaster preparedness and mitigation: participatory risk assessment, multi-hazard mapping, and training on community-based disaster risk management for community and community trainers.
2. Activities for strengthening LGU capacities' disaster risk reduction: developing standards, guidelines, and protocols on emergency response; emergency response preparedness training; municipal contingency planning; barangay contingency planning; evacuation drills for communities and schools.
3. Setting up the Saint Bernard Emergency Response Unit.
4. Setting up a community-based early warning system.
5. Provision of disaster preparedness and early warning system (EWS) equipment.
6. Small-scale mitigation projects: construction of gabion (large wire baskets filled with rocks to stabilize shorelines or slopes) as flood mitigation measure and dredging of Lawigan River.
7. Relocating communities in danger zones to areas less prone to hazards.
8. Establishment of coconet (which makes use of coconut husk fibers to produce a tough but biodegradable netting that anchors the soil on sloping land to protect against erosion and encourage vegetation growth) on mountain steep slopes to lessen landslides in Saint Bernard.
9. Updating the CLUP using identified risk factors from the Hazards Mapping and Assessment for Effective Community-Based Disaster Risk Management (also known as the READY Project), multi-hazard mapping, and vulnerability assessment of communities and municipalities.
10. Establishment of permanent relocation sites for households living along the riverbanks who are prone to flood/flashfloods and along the coast who are prone to storm surge and tsunami, in partnership with Gawad Kalinga, an NGO.
11. Establishment of Flood Early Warning System by GTZ. The EWS operates by a telemetered device that would transmit data (such as rainfall volume and water level of floods at the upstream river) to the operation center via radio frequency.

As a result of the efforts to improve disaster preparedness and land use plans, Saint Bernard was a recipient of the Gawad Kalasag Award, a recognition given to LGUs exhibiting excellence in disaster risk reduction and management and humanitarian assistance by the National Disaster Risk Reduction and Management Council in 2008. Saint Bernard was cited for having the most exemplary Disaster Risk Reduction and Management Council and the best contingency plan and disaster preparedness/disaster risk reduction and management program.

11.4 Lessons and Implications to Land Use Policy in the Philippines

11.4.1 The Need to Review Land Use Policy

Evans et al. (2007) explain that heavy rainfall, active tectonics, frequent earthquakes, and extensive tropical weathering make the Philippines prone to catastrophic landslides. In Southern Leyte where detailed large-scale geological mapping has not been undertaken, it was a general observation that the Guinsaugon landslide was a disaster just waiting to happen. Disasters like the Guinsaugon, Leyte landslide demonstrate why the country urgently needs a land use policy that takes into consideration the many hazards and the interdependent ecosystems in the country as well as future risks posed by climate change. An overarching framework needs to be institutionalized to guide LGUs in land use planning that balances sustainable development and disaster risk reduction.

In public policy, disasters serve as focusing events or policy windows. Birkland (1997) argues that catastrophes gain the greatest attention since they provide prima facie evidence of a policy failure. He calls policies ratified after a disaster as a policy failure-inspired learning. He provided three key arguments in support of event-related policy change including (i) catastrophes could lead to policy change; (ii) the larger the disaster in terms of loss, lives claimed, and property damaged, the larger the potential for policy change; and (iii) disasters do in an instant what policy advocate may fail or not been able to do—bringing to the fore an issue to the table where policy makers will take it more seriously and urgently (Birkland 2006).

11.4.2 The Importance of Risk-Sensitive Land Use Planning

The Guinsaugon landslide brought Southern Leyte to the attention of the national government and humanitarian agencies and enabled the local government and community to acknowledge the value of disaster risk reduction and effective land use plans. It highlighted local vulnerabilities, particularly geologic conditions (e.g., the presence of fault) and inappropriate land use practices (e.g., flooded paddy fields). Gaps were observed such as (i) lack of a good network of rain gauges or precipitation radars to predict and monitor, (ii) nonexistence of a comprehensive disaster mitigation program (including geohazard information, land use planning, and systematic warning and evacuation procedures) at the *barangay* level, and (iii) government's failure to address geohazards in the province of Leyte despite previous occurrence of similar disasters (PCIJ 2006).

The vulnerability of mountain areas is increasing due to human-induced changes and the impacts of climate change with considerable effects on biodiversity, slope stability, and hydrology. Thus, there is a need to focus research and activities on local context of source area, post-failure behavior, and trigger and early warning in formulating a hazard assessment strategy (Evans et al. 2007). An example is given by Zingari and Fiebiger (2002) which recommends steps to planning for safety and reducing risks such as risk analysis; risk identification; risk assessment including event analysis, impact analysis, and exposition analysis; risk valuation; and planning and implementing countermeasures. Moreover, the Regional Consultative Committee on Disaster Management presents case studies of best practices on integrating risk information into land use planning including (i) hazard characterization, (ii) incorporating disaster risk information in local planning, (iii) hazard vulnerability and zonation mapping, (iv) incorporating hazard risk information in land use plans by taking advantage of post-disaster reconstruction, (v) mainstreaming disaster risk reduction in land use and physical planning, and (vi) principles and practice of ecologically sensitive urban planning and design, among others (ADPC 2011).

Generally, land use decisions are made by the government, often biased toward meeting development needs without consideration of disaster or climate change risks and environmental changes. Land zoning, mapping, and monitoring are critical as they point to locations of different levels of hazard potentials where mitigation measures need to be applied. For example, engineering countermeasures such as the use of slope stabilization methods (e.g., benching, improvement of subsurface drainage, construction of retaining structures, and reinforcement of slopes) can be resorted to for landslide reduction (Kuwano et al. n.d.).

11.4.3 The Merits and Challenges of Public Participation in Land Use Planning After a Disaster

In the aftermath of a disaster, public participation in land use planning becomes critical. Land use planning plays an important role in the reconstruction phase as it provides an opportunity to rebuild differently, if not better, while considering exposure and vulnerability to current and future risks (World Bank 2010). The Disaster Recovery Toolkit prepared under the Tsunami Global Lessons Learned Project reiterates that *land use planning provides a tangible risk reduction opportunity and can support the overall recovery process* (ADPC 2015, 28). In this light, the ultimate goal of land use planning in the post-disaster context is to build back better and enhance resilience.

The need to rebuild and reconstruct areas and communities affected by disasters is immediate. As evident in the areas hit by large-scale disasters such as the 2004 Asian tsunami, Haiti earthquake 2010, Mt. Merapi eruption in 2010, and Super Typhoon Haiyan 2013, recovery policies were mostly drafted in the post-disaster phase under time pressure. That said, there was limited or no government space at all for active engagement of high-risk communities in planning and decision-making processes. It can be very well argued that aside from the time element, nonparticipation of the public, particularly the affected populations in land use planning, is brought about by a government mind-set that communities are not knowledgeable and skilled in the land use planning process. Also, there is a predominant understanding that land use planning is only done by experts and licensed planners who have the technical know-how. At the very least, land use planners need to refer and carefully consider community/participatory risk assessment results produced with and/or in partnership with the public to ensure that the experiences, needs, and other important concerns of vulnerable citizens are taken into consideration in the land use planning process. Land use planning, zoning, and management must be well-informed and with stakeholder participation to ensure effective implementation.

A good example of giving importance to people's participation in spatial planning for village level reconstruction is provided by the Agency for Rehabilitation and Reconstruction of Aceh and Nias (BRR). The BRR issued a guideline on village level planning in 2005, a year after Aceh and Nias incurred damages as a result of the 2004 Asian Tsunami. The participatory land use planning process highlighted three levels of planning depending on the size and complexity of the reconstruction project: (i) rapid site plan (less than 20 houses), (ii) minimum settlement plan (20–150 houses), and (iii) better settlement plan (more than 150 houses). A primary reason behind public participation in the initiative is the general goal to develop village plans restoring original conditions, but integrating disaster mitigation (ADPC 2015). As mentioned earlier, the Guinsaugon, Leyte recovery also placed high importance on participatory and bottom-up land use and development planning allowing affected communities to participate in risk reduction activities and subsequently receiving recognition for their efforts.

Public participation in land use planning after a disaster is an emerging practice. The inclusion of the public in land use planning discourse and practice is a challenge to the traditional development approach, which has always been "top down" rather than "bottom up." This is evident on how communities are perceived to be merely beneficiaries of development initiatives and predominantly seen as recipients and passive actors in the development process rather than active agents of societal change. Subsequently, communities, particularly those that are poor and vulnerable to disasters, do not often have the political voice and capital to engage in the decision-making process such as in land use planning. Also, the public have been merely audience in the process rather than actively engaged in the development discourse and practice.

Public participation is the basic building block for contemporary democratic society and sustainable communities (Cuthill and Fien 2006). Bloomfield et al. (1998) reiterate the need for multiple knowledge in decision-making in a participatory democracy where there is active, as opposed to passive and withdrawn, engagement of citizens in current issues. As Arnstein (1969, 216) argues, *the participation of the governed* is the cornerstone of democracy.

11.5 Conclusion

The Guinsaugon, Leyte landslide was a focusing disaster event that brought to light gaps in land use planning and policy in the country. It highlighted current risks presented by mountain hazards to life, property, and livelihoods as well as future risks presented by climate change and environmental changes. Pending the passage into law of the National Land Use Act, it is important to revisit the proposed land use policy to ensure disaster and climate risks are incorporated and participatory and risk-sensitive land use planning is made requisite. For the mountainous regions of the country which are often neglected in development initiatives, the national and local governments need to focus on prioritizing the review of the CLUPs of the LGUs in these areas in order to incorporate disaster and climate risks. Guidelines developed by HLURB need to be urgently disseminated to the ground to increase awareness of mountain hazards and risks and develop appreciation of the CLUP process in general. The relevant government agencies need to strengthen their programs related to land use and effectively cascade them to the local level. Implementation of the land use plan remains problematic, and oversight and monitoring would be necessary to enforce periodic reporting and review of land use plans. However, it is hoped that the lessons of the Guinsaugon, Leyte disaster will strengthen land use decisions especially in the mountain regions of the country and make the case for the adoption of the National Land Use Act.

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Chapter 12
Japan's Experiences of Catastrophic Mountain Disasters in Wakayama

Yohei Chiba, Rajib Shaw, and Michiko Banba

Abstract Wakayama Prefecture is a part of the Kii Peninsula, one of the most typhoon- and rainfall-prone areas in Japan, while the 80 % of its land is covered by precipitous mountains. Due to its geographical and geological characteristics, Wakayama has ever suffered repeated sediment disasters, such as debris flows, slope failure, and landslides, since ancient times. To address sediment disasters, Wakayama has taken structural and nonstructural preventive measures, such as sediment control dams and designation of sediment disaster warning areas where warning and evacuation systems must be established and also certain development activities are restricted. However, Wakayama suffered significant damages from Typhoon No. 12 in 2011. The record-breaking heavy rainfall by Typhoon No. 12 caused sediment disasters and river flooding in many places around Wakayama. Consequently, this disaster resulted in the highest deaths of 56, out of the total 82 deaths in all prefectures. Out of 56 deaths, 35 people were victims of sediment disasters. This chapter focuses on sediment disasters in Wakayama from a perspective of disaster risk reduction. It examines current preventive measures against sediment disasters in Wakayama, especially its nonstructural preventive measures, such as designation of warning and special warning areas for sediment-related disasters, which plays vital roles as the land use zoning. It finally identifies issues and challenges on how to improve its current nonstructural measures, based on the lesson learned from Typhoon No. 12 in 2011.

Keywords Land use policy • Land use zoning • Disaster risk reduction • Nonstructural measures • 2011 Typhoon No. 12

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12.1 Introduction

Japan is one of the most prone countries to natural disasters. It is located in the Pacific Ring of Fire and has suffered earthquake- and volcanic eruption-related disasters. In addition, wind- and flood-related disasters have occurred by typhoons and seasonal rain fronts in the monsoon season year after year. In recent years, heavy rainfalls by typhoons and seasonal rain fronts have often occurred that caused sediment disasters, such as debris flows, slope failure, and landsides. These disasters are likely to cause catastrophic damages especially at mountainous and vulnerable tectonic areas.

In the meanwhile, since the postwar years of economic growth of Japan, rapid demographic shift to urban areas had happened. That led to acceleration of housing land development and housing construction at suburban and peripheral areas. Consequently, sediment hazardous places, such as artificial slopes, have increased. Such housing construction and development activities have been regulated by land use policies, including the Building Standards Act, the Act on Regulation of Residential Land Development, and the City Planning Act (Yagi 2007). On the other hand, it is also crucial to prepare for and prevent sediment disasters. Sediment disasters have been ever addressed particularly by the Erosion Control Act, the Landslide Prevention Act, the Act on Prevention of Disasters Caused by Steep Slope Failure, and the Act on Sediment Disaster Countermeasures for Sediment Disaster Prone Areas.

Wakayama Prefecture is a part of the Kii Peninsula, one of the most typhoon- and rainfall-prone areas in Japan. Wakayama has often suffered sediment disasters since ancient times. The 80 % of its land is covered by precipitous mountains. Recently, Wakayama suffered significant damages from sediment disasters by Typhoon No. 12 in 2011. The main objective of the chapter is to examine current preventive measures against sediment disasters in Wakayama, focusing on nonstructural preventive measures under the Act on Sediment Disaster Countermeasures. The related reports, surveys, and data by the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and Wakayama prefectural government are reviewed and analyzed. The chapter first tracks the transition of Japan's policies on sediment disasters from a perspective of disaster risk reduction. It then looks at geographic characteristics of Wakayama and its past and recent sediment disasters. It examines its current preventive measures against the disasters, especially its nonstructural preventive measures under the Act on Sediment Disaster Countermeasures, such as designation of warning and special warning areas for sediment-related disasters, one of the most principal land use zoning in terms of disaster risk reduction. Finally, it discusses how to improve its current nonstructural preventive measures, based on the lesson learned from Typhoon No. 12 in 2011.

12.2 Transition of Japan's Policies on Sediment Disasters

Severe wind- and flood-related disasters and accompanying sediment disasters have ever made powerful impacts to establish and revise Japan's policies to address the disasters. Looking at past transition of the relevant policies (Table 12.1), until the twenty-first century, such disasters had been addressed by structural preventive measures, such as the Erosion Control Act, the Landslide Prevention Act, and the Act on Prevention of Disasters Caused by Steep Slope Failure.

The Erosion Control Act (*Sabo-ho*) was established in 1897, in response to a catastrophic flood disaster in 1894. The act aims to make sediment control by disaster prevention, through green restoration, prohibition or restriction of harmful activities to bald mountains, control of sediment production, and regulation of sediment runoff (MLIT n.d.-a). The Landslide Prevention Act was enforced in 1958 to address landslides, in the wake of the 1957 landslide disaster in western Kyushu region. The Act on Prevention of Disasters Caused by Steep Slope Failure was formed in 1969 to prevent steep slope failure, in response to the 1967 heavy rainfalls and landslide disasters in western Japan. Slope failure had not been covered by the Erosion Control Act and the Landslide Prevention Act.

Table 12.1 Transition of Japan's policies related to sediment disasters

Enactment	Relevant policies	Triggered disasters
April 1896	River Act	Catastrophic flood disaster
March 1897	Erosion Control Act (*Sabo-ho*)	In 1894
June 1949	Flood Control Act	Typhoon Kathleen in 1947
May 1956	Coast Act	Heavy rainfall in western Japan in 1953, Typhoon No. 13 in 1953
March 1958	Landslide Prevention Act	Landslide disaster in western Kyushu region in 1957
July 1969	Act on Prevention of Disasters Caused by Steep Slope Failure	Heavy rainfall, landslide disaster by heavy rainfall in western Japan in 1967
March 2001	**Act on Sediment Disaster Countermeasures for Sediment Disaster Prone Areas**	Heavy rainfall, sediment disaster in Hiroshima in 1999
May 2004	Act on Countermeasures against Flood Damage of Specified Rivers Running Across Cities	Flood disaster in Fukuoka in 1999 and 2003, heavy rainfall in Tokai region in 2000
July 2005	Partial Amendments to Flood Control Act; **Act on Sediment Disaster Countermeasures** (**Point**: **Raise awareness by hazard map**)	Heavy rainfall in Niigata, Fukushima, and Fukui in 2004
May 2011	Partial Amendment to **Act on Sediment Disaster Countermeasures** (**Point**: **Provision of sediment disaster-related information to municipalities**)	Mid-Niigata Prefecture Earthquake in 2004, Iwate-Miyagi Nairiku Earthquake in 2008

Source: Prepared by Authors from MLIT (2011)

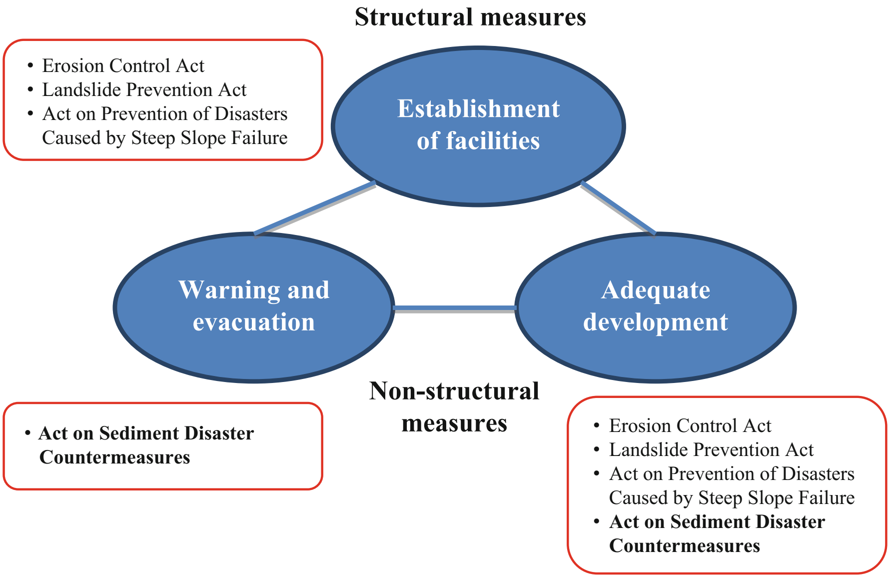

Fig. 12.1 Positioning of the Act on Sediment Disaster Countermeasures (Source: Prepared by Authors from MLIT 2011)

On the other hand, the 1999 sediment disasters in Hiroshima served as a trigger to enhance nonstructural preventive measures against sediment disasters. As a result, the Act on Sediment Disaster Countermeasures for Sediment Disaster Prone Areas was established in 2001 to designate sediment-related disaster warning areas and establish warning and evacuation system. A comprehensive discussion of the Act on Sediment Disaster Countermeasures is presented in the following sections. Therefore, Japan's current policies to address sediment disasters are based on the above four acts.

Figure 12.1 shows how the key four acts are positioned as structural and nonstructural preventive measures. Structural preventive measures represent establishment of facilities to address sediment disasters, while nonstructural preventive measures include warning and evacuation and adequate development. First of all, development activities have been regulated under the four acts. Specifically, sediment control areas and landslide prevention areas where certain activities including cutting off land and filling up land are restricted have been designated by the Erosion Control Act, the Landslide Prevention Act, and the Act on Prevention of Disasters Caused by Steep Slope Failure. On the other hand, sediment-related disaster special warning areas ("red zone") where building structures and certain development activities are regulated have been designated by the Act on Sediment Disaster Countermeasures. Secondly, warning and evacuation have been regulated under the Act on Sediment Disaster Countermeasures. Particularly, sediment-related disaster warning areas ("yellow zone"), where a hazard map of sediment disasters is required to be developed and warning and evacuation system must be enhanced, have been designated. Thirdly, establishment of facilities is based on the Erosion Control Act, the Landslide Prevention Act, and the Act on Prevention of Disasters Caused by Steep Slope Failure. This includes sediment control works, landside control works, and steep slope failure control works.

12.3 Geographical Profile of Wakayama

Wakayama Prefecture ("Wakayama") faces the Pacific Ocean (Fig. 12.2). It is located in the the Kii Peninsula, the largest peninsula in Japan, in the Kansai region on Honshu Island. The total population is 970,903, and the total number of households is 399,457 as of October 1, 2014 (Wakayama Prefecture n.d.-a). The total area is 4726 km^2 and ranked as the 30th out of 47 prefectures in Japan. The total inhabitable area is 1101 km^2 and ranked as the 31st (Wakayama Prefecture n.d.-b). The forest area is 363,040 ha and covers 77 % of the total area. The portion of the forest area is ranked as the sixth out of 47 prefectures (MAFF n.d.).

The large portion of Wakayama is a mountainous terrain, so that it is called as "the land of wood (*kinokuni*)." There are a lot of precipitous mountains around 1000 m above sea level. Mountains such as Izumi, Nagamine, Shirama, and Hatenashi range from east-northeast to west-southwest. There are 317 rivers in Wakayama (Wakayama Prefecture n.d.-f). Most rivers are sourced from these mountains, erode many valleys, and drain into the Pacific Ocean.

The average annual precipitation of Wakayama is about 1300 mm, and the southern mountainous terrain has a high annual precipitation. In particular, Nachikatsuura Town has its annual precipitation over 3500 mm (Wakayama Local Meteorological Observatory n.d.).

Fig. 12.2 Location of Wakayama Prefecture (Source: Prepared by Authors from Sankakuke n.d..)

12.4 Sediment Disasters in Wakayama

The 80 % of Wakayama's land is covered by mountainous terrain with a small proportion of its flatland. The basements are weak, and rivers are steep. In addition to these geographical and geological characteristics, Wakayama is a part of the Kii Peninsula, one of the most typhoon- and rainfall-prone areas in Japan. Due to seasonal rain fronts in the monsoon season or being constantly attacked by typhoons, Wakayama has suffered many debris flows, landslides, and slope failure since ancient times.

Looking at the past few decades, there are several major disasters where Wakayama suffered sediment damages, including the flood disaster in 1953, Ise Bay typhoon in 1959, second Muroto typhoon in 1961, Typhoon No. 10 in 1982, and torrential rainfall in 1995 (Table 12.2). In particular, the 1953 flood disaster was recorded as the most severe climatic disaster in the history of Wakayama (referred to as "7.18 flood disaster"). The torrential rainfall by seasonal rain fronts before and after July 18 in 1953 hit the northern Wakayama. It recorded the total precipitation per 24 h over 500 mm in mountain areas. It caused severe mountainous debris flows, landslides, slope failure, floods, and washout of rivers, such as the Arida River and Hidaka River. Consequently, this resulted in 713 deaths, 411 missing, 5819 injured,

Table 12.2 Past major sediment disasters in Wakayama

Occurrence	Name of disasters	Overview
July 1953	Flood disaster on July 18 (7.18 flood disaster)	Mountainous slope failures in the upper reaches of Arida River extended to 2270 sites. Turbid torrents flushed soils and woods. Humans, animals, houses, buildings, and cultivated fields were filled by a large mass of mud
September 1959	Typhoon Ise Bay	Total precipitation reached 500 mm and the whole area of Wakayama was damaged. Consequently, the special emergency sediment control works were carried out on Kinokawa River, Arida River, Hikigawa River, and Tonegawa River
September 1961	Typhoon Second Muroto	The special emergency sediment control works were carried out on Arida River, Hikigawa River, and Hidaka River. The amount of damage was over 33.9 billion yen
August 1982	Typhoon No. 10	The maximum rainfall per hour reached 28 mm. In Katsuragi town, 400,000 m^3 (300 m of height and 500 m of width) of slopes flowed out
July 1995	Torrential rainfall by seasonal rain front early in summer	Mudflows and mountainous slope failures occurred in various sites. Road and railroad were cut off. 14 houses were half destroyed
October 1995	Passage of cyclone	The total precipitation was 280 mm and the maximum rainfall per hour was 82 mm. 5000 m^3 of slope became mudflow, and it attacked a house. Three people were killed, four people were injured, and nine houses were full/half destroyed

Source: Prepared by Authors from Wakayama Prefecture (2002)

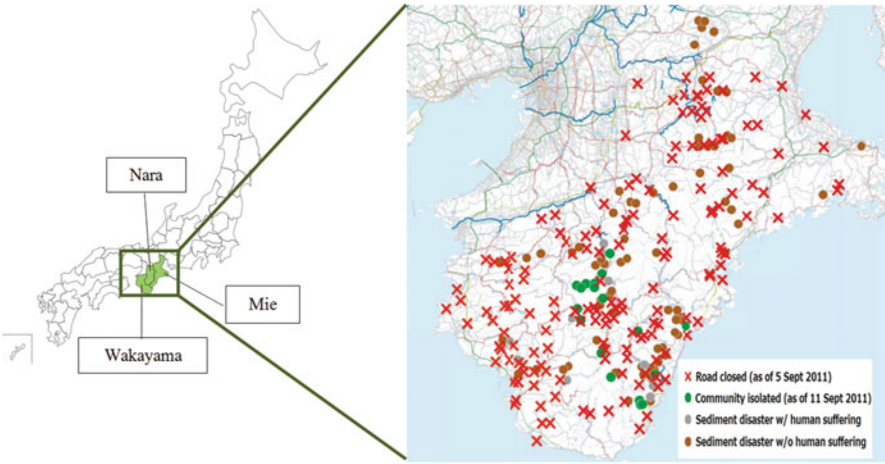

Fig. 12.3 Sediment disasters by Typhoon No. 12 in 2011 (Wakayama, Mie, Nara) (Source: Prepared by Authors from Sankakuke n.d.; Kinki Regional Development Bureau 2013)

7704 full-destroyed houses, 2125 half-destroyed houses, 20,277 houses flooded above the floor, and 66,202 houses flooded below the floor (JMA n.d.-a).

Considering the recent past 5 years, Wakayama was severely damaged from Typhoon No. 12 in 2011. Typhoon No. 12 was formed as a tropical depression over the sea west of the Mariana Islands on August 24, 2011. It moved slowly northward and developed into a typhoon on August 30. On September 3, it made landfall on Shikoku Island and reached the Sea of Japan on the next day after crossing Shikoku and Chugoku regions. Since it had a large-scale strong wind area and moved very slowly, it induced moisture advection for many hours and caused the record-breaking heavy rainfall over a wide area from western to northern Japan (JMA n.d.-b). In Wakayama, 14 observation stations out of total 18 stations recorded heavy rainfall with its historic high of precipitation per 72 h, such that the observation station of Nishikawa, Kozagawa town, recorded 1114 mm (Wakayama Prefecture n.d.-e).

The record-breaking heavy rainfall by Typhoon No. 12 caused sediment disasters in many places in Wakayama and other prefectures, such as Mie and Nara. Wakayama, Mie, and Nara suffered 28, 40, and 33 sediment disasters for each, as of October 28, 2013 (MLIT 2013). Due to the sediment disasters, national and prefectural roads were closed at 236 places, and 18 communities were isolated in the three prefectures (Fig. 12.3).

In Wakayama, there were 24 debris flows, two landslides, and two slope failures, as of October 28, 2013 (MLIT 2013). In Kumano area in Tanabe city, landslide dams were generated by large-scale slope failure. In the Nachi River basin, there were tremendous damages from debris flows. Consequently, Wakayama recorded

Table 12.3 Overview of damages in Wakayama from 2011 Typhoon No. 12

Damage category	Number of occurrences	Amount (million yen)
Persons:		
Killed	56	–
Missing	5	–
Houses/buildings:		
Full destroyed	367	–
Half destroyed	1840	–
Partially destroyed	170	–
Others:		
Rivers	842	21,748
Coasts	1	32
Sediment controls	35	1366
Steep slopes	1	40
Roads	288	12,933
Bridges	10	629
Harbors	4	107

Source: Prepared by Authors from Wakayama Prefecture (n.d.-e)

the highest deaths of 56, out of the total 82 deaths in all prefectures, due to sediment disasters and river flooding by 2011 Typhoon No. 12 (FDMA 2012) (Table 12.3). Thirty-five people out of 56 deaths were victims of sediment disasters.

12.5 Land Use-Related Policy in Terms of DRR in Wakayama

Land use policies in terms of disaster risk reduction represent land use policies and land use plans into which disaster risk reduction is integrated. In Japan, such land use policies are ahead in the area of sediment disasters (Yoshikawa 2011). The key laws relevant to land use policies on sediment disasters include the Erosion Control Act, the Landslide Prevention Act, the Act on Prevention of Disasters Caused by Steep Slope Failure, and the Act on Sediment Disaster Countermeasures for Sediment Disaster Prone Areas. On other hand, the major laws related to land use policies regardless of the type of a disaster include the Building Standards Act, the Act on Regulation of Residential Land Development, and the City Planning Act. This section first describes structural preventive measures against sediment disasters in Wakayama Prefecture. It then explains its nonstructural preventive measures under the Act on Sediment Disaster Countermeasures, focusing on designation of warning and special warning areas for sediment-related disasters, which plays a key role in the land use zoning.

Table 12.4 The occurrence status of sediment disasters in Wakayama

Year	2006	2007	2008	2009	2010	2011	2012	2013
Debris flow	0	3	1	8	2	28	0	3
Landslide	3	1	1	0	0	6	1	0
Slope failure	12	10	10	18	2	10	1	7
Total	**15**	**14**	**12**	**26**	**4**	**44**	**2**	**10**

Source: Prepared by Authors from MLIT (n.d.-c)

Table 12.5 Structural measures against sediment disasters in Wakayama

Type of disasters	Structural measures
Debris flow	Sediment control dams to directly receive debris flows (Fig. 12.4)
	Sediment control dams, groundsill, and revetment works to prevent riverbed and riverbank from wearing down by the flow of water and to fix spur
Landslide	Restraint works to stop the movement of landslides by force
	Control works to stop the movement of landslides by changing natural conditions such as groundwater
Slope failure	Countermeasure works to cut off hazardous cliffs
(Rockslide)	Concrete-block pitching, slope frameworks, planting works to protect the surface of cliffs
	Retaining wall works to receive sediment flows

Source: Prepared by Authors from Wakayama Prefecture (n.d.-d)

As shown in Table 12.4, Wakayama Prefecture has ever suffered repeated sediment disasters, such as debris flows, landslides, and slope failure, year after year. To address the sediment disasters, Wakayama has taken structural and nonstructural preventive measures, under the abovementioned regulations.

12.5.1 Structural Preventive Measures Against Sediment Disasters

First of all, Wakayama Prefecture has taken structural preventive measures against sediment disasters, that is to say, countermeasure works. The structural measures are taken in accordance with the types of the disasters: sediment control dams, groundsill, and revetment works against debris flows; restraint and control works against landslides; and works to cut off hazardous cliffs, concrete-block pitching, slope frameworks, planting works, and retaining wall works against slope failure (Table 12.5 and Fig. 12.4).

(a) Debris flows (b) Sediment control dam

Fig. 12.4 Iseki-Ichinono district, Nachikatsuura town, Wakayama. (**a**) Debris flows, (**b**) sediment control dam (Source: Prepared by Authors on October 16, 2014)

12.5.2 Nonstructural Measures Against Sediment Disasters

Wakayama has also taken nonstructural preventive measures against sediment disasters. The purposes are to awaken residents to the principle of disaster risk reduction that “protect oneself”, let them check surrounding hazardous areas, give them consciousness of escaping from disasters in emergencies, and provide them important information for their decision-making, including precipitation and sediment hazardous places. The nonstructural measures of Wakayama and other prefectures are based on the Act on Sediment Disaster Countermeasures for Sediment Disaster Prone Areas (“Act on Sediment Disaster Countermeasures”).

12.5.3 The Act on Sediment Disaster Countermeasures

It is a situation that sediment hazardous places have increased with new residential development, while sediment disasters have occurred year after year all over the country. In addition, tremendous costs and time are required to make all the sediment hazardous places secure by doing countermeasure works. As a result, the act on Sediment Disaster Countermeasures was established in 2001 to enhance nonstructural preventive measures against sediment disasters, in conjunction with structural measures, such as countermeasure works.

The Act on Sediment Disaster Countermeasures falls into two major intentions. One is to clearly designate sediment hazardous areas (i.e., sediment-related disaster warning areas and sediment-related disaster special warning areas), establish warning and evacuation systems in the areas, restrict development activities in severe sediment disaster-prone areas, and regulate building structures. The second is to promote the nonstructural measures by providing important information for evacuation in imminent dangers of severe sediment disasters.

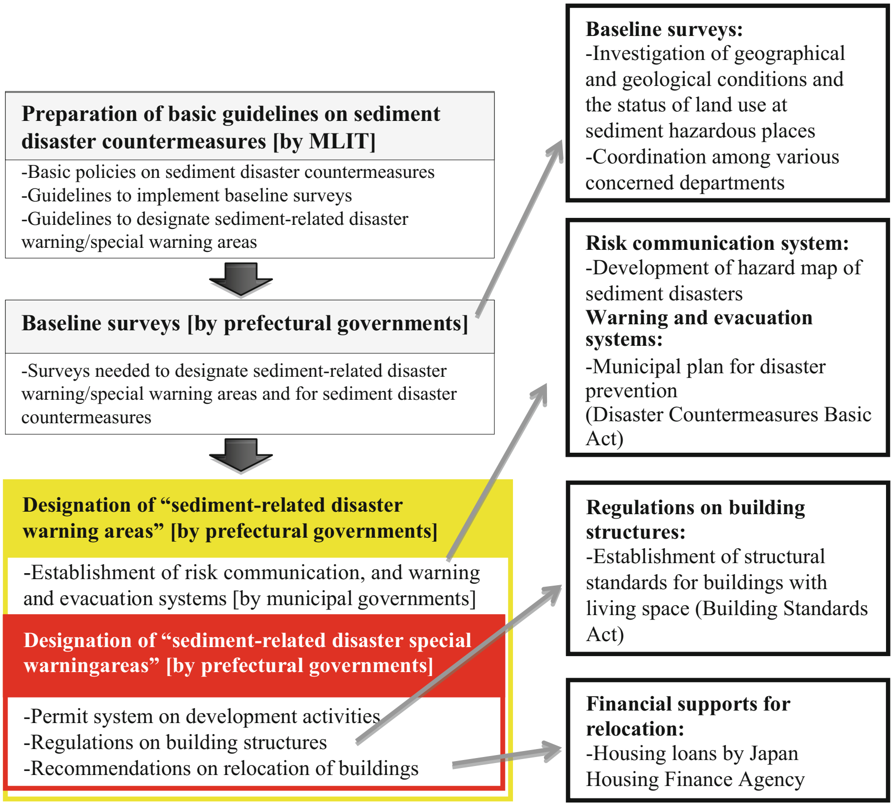

Fig. 12.5 Overview of the Act on Sediment Disaster Countermeasures (Source: Prepared by Authors from MLIT n.d.-b)

The basic guidelines on sediment disaster countermeasures are prepared by the Ministry of Land, Infrastructure, Transport and Tourism, Japan (MLIT). Based on the guidelines, prefectural governments implement baseline surveys to investigate sediment disasters, geographical and geological conditions, and the status of land use and buildings at sediment hazardous places and then designate "sediment-related disaster warning areas" and "sediment-related disaster special warning areas." Municipal governments establish warning and evacuation systems in the designated areas (Fig. 12.5).

12.5.4 Land Use Zoning in Terms of DRR

To make Wakayama prefectural land more secure, it is necessary to comprehensively designate sediment hazardous places, in conjunction with various land use plans and land use policies in terms of disaster risk reduction. Land use of Wakayama

Prefecture has been implemented based on its Land Use Master Plan ("land use plan"), which must also carefully consider whether an area is vulnerable to a disaster under the National Land Use Planning Act (Wakayama Prefecture 2013). Its land use plan stipulates five types of areas which are regulated by different laws for each, such as the urban area (the City Planning Act), agricultural area (the Act on Establishment of Agricultural Promotion Regions), forest area (the Forest Act), natural park area (the Natural Parks Act), and nature conservation area (the Nature Conservation Act).

From a perspective of disaster risk reduction, there are various regulations on land use zoning (Table 12.6). Land use zoning to address sediment disasters includes the erosion control area, the landslide-threatened area (the Landslide Prevention Act), the steep slope landslide hazard area (the Act on Prevention of Disasters Caused by Steep Slope Failure), and the sediment-related disaster warning and special warning area (the Act on Sediment Disaster Countermeasure). On the other hand, land using zoning regardless of the type of a disaster includes the disaster hazard area (the Building Standards Act), the housing land development construction regulated area (the Act on Regulation of Residential Land Development), and urbanization promotion area and the urbanization control area (the City Planning Act).

Particularly, designation of the warning and special warning areas for sediment-related disasters under the Act on Sediment Disaster Countermeasure plays imperative roles because these focus on inhibition of inhabitation and establishment of risk communication, warning, and evacuation system at sediment hazardous places, while other land use policies put more emphasis on countermeasure works than inhibition of inhabitation at the hazardous places. Designation of the warning and special warning areas, including implementation of the baseline surveys, is managed by the Sediment Control Division of Wakayama Prefecture, with other relevant divisions and departments, such as its Urban Policy Division and Building and Housing Division.

12.5.5 Sediment-Related Disaster Warning Areas

A sediment-related disaster warning area, commonly known as "yellow zone," is an area vulnerable to sediment disasters where residents are at risk of their lives and health (Fig. 12.6). In terms of slope failure, it is an area with slope gradient of over 30° and slope height of over 5 m, horizontal distance of below 10 m from the top edge of the slope, and slope height of below twice as high from the bottom edge of the slope (50 m is applied for the height of over 50 m). Regarding debris flows, it is an area with slope gradient of over 2° at the bottom edge from the crest of the alluvial fan. In regard to landslides, it is an area vulnerable to landslides and with a distance equivalent to the length of a mass of the landslide from the bottom edge of the landslide area (250 m is applied for the length of over 250 m).

Table 12.6 Land use zoning in terms of DRR

Types of disasters	Name of policies	Name of designated areas	Overview
Sediment disasters	Erosion Control Act	Erosion control area	An area necessary for erosion control facilities, where certain harmful activities are prohibited or restricted
	Landslide Prevention Act	Landslide-threatened area	An area that foments and causes landslides or vulnerable to landslides, where control works and certain harmful activities are restricted
	Act on Prevention of Disasters Caused by Steep Slope Failure	Steep slope landslide hazard area	An area that threatens to harm most residents due to steep slope failure, where activities which foment and cause the failure must be restricted
	Act on Sediment Disaster Countermeasure	**Sediment-related disaster warning area**	**See the section of "12.5.5"**
	Sediment-related disaster special warning areas		**See the section of "12.5.6"**
Sediment disasters and other natural disasters	Building Standards Act	Disaster hazard area	A hazard area severely vulnerable to natural disasters, such as tsunamis, storm surges, and floods
	Act on Regulation of Residential Land Development	Housing land development construction regulated area	An urban area or land to be urban area severely vulnerable to natural disasters due to housing land development, where relevant works are restricted
	City Planning Act	Urbanization promotion area	An area where an urban area has been formed and that should be preferentially and systematically urbanized within 10 years
		Urbanization control area	An area that urbanization should be restricted, where development is generally prohibited for the time being

Source: Prepared by Authors from Yagi (2007) and Yoshikawa (2011)

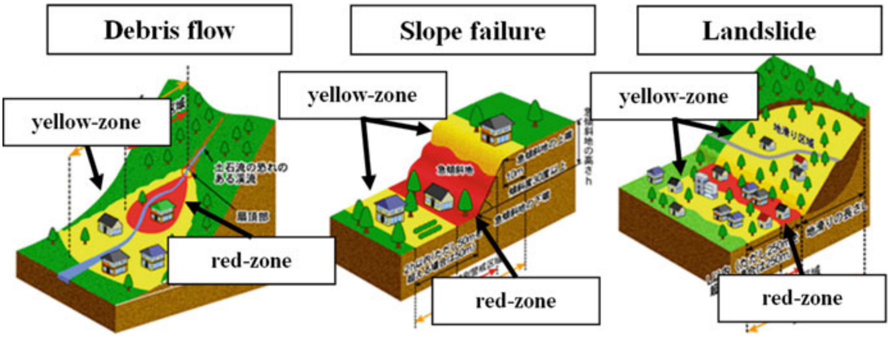

Fig. 12.6 Sediment-related disaster warning and special warning areas (Source: Wakayama Prefecture n.d.-c)

At the warning areas, the warning and evacuation systems must be integrated into the municipal plan for disaster prevention. The major purpose of these systems is to protect vulnerable people such as the elderly and the disabled. In addition, sediment disaster-related information through a hazard map of sediment disasters is disseminated. Furthermore, as a measure under the Building Lots and Buildings Transaction Business Act, real estate transaction brokers are required to explain as a substantive matter that the real estates are located in the warning area for the sale of real estates.

12.5.6 Sediment-Related Disaster Special Warning Areas

A sediment-related disaster special warning area, commonly known as "red zone," is an area vulnerable to sediment disasters where residents are at severe risk of their lives and health (Fig. 12.6). It is an area where the magnitude of force acting on a building by the movement of debris and rocks caused by slope failure exceeds the tolerance level that an ordinary building can endure the movement without causing severe risk to residents' lives and health. In terms of landslides, the magnitude of force acting on a building in 30 min after debris and rocks by landslides start acting on the building is applied. In this case, it is an area with a distance of below 60 m from the bottom edge of the landslide area.

At the special warning areas, certain development activities in selling building lots and building facilities for the elderly and the disabled are permitted only if these activities meet the technical standards needed to ensure the safety. To prepare for slope failure, whether or not to meet structural standards for buildings with living space must be confirmed by a builder before undertaking building. Moreover, relocation of building from the special warning area to a safe area can be recommended to the owner of the building. The cost for relocation can be supported through housing loans by Japan Housing Finance Agency and grants for comprehensive

Table 12.7 Sediment hazardous places by prefecture

Rank	Name of prefecture	Debris flow prone[a]	Landslide prone[b]	Slope failure prone[c]	Total	Share (%)
1	Hiroshima	9964	80	21,943	31,987	6.1 %
2	Shimane	8120	264	13,912	22,296	4.2 %
3	Yamaguchi	7532	285	14,431	22,248	4.2 %
6	**Wakayama**	**5745**	**495**	**12,247**	**18,487**	**3.5 %**
	All prefectures	**183,863**	**11,288**	**330,156**	**525,307**	**100 %**

Source: Prepared by Authors from MLIT (n.d.-d)
[a]The numbers of places prone to debris flows are based on the data on 2002 fiscal year
[b]The numbers of places prone to landslides are based on the data on 1998 fiscal year
[c]The numbers of places prone to slope failure are based on the data on 2002 fiscal year

infrastructure development. Furthermore, as a measure under the Building Lots and Buildings Transaction Business Act, real estate transaction brokers cannot advertise real estates and conclude a sale contract unless they are specifically permitted for the development activities. They are also required to explain the permission for the development activities as a substantive matter for the sale of real estates.

12.5.7 Current Status of Yellow Zone and Red Zone in Wakayama

Japan's national soil is originally vulnerable to sediment disasters due to its geological structures of mountainous terrain. In addition, acceleration of housing land development and housing construction at suburban and peripheral areas by its economic growth has aggravated this situation, regardless of existing land use policies and plans, such as designation of the urbanization control area under the City Planning Act. As a result, sediment hazardous places have increased. Thus, it is important to inhibit inhabitation at sediment hazardous places by clearly designating them as warning and special warning areas for sediment-related disasters.

According to the MLIT, there are 525,307 sediment hazardous places all over the country. Hiroshima, Shimane, and Yamaguchi are ranked in the top three prefectures with the most numbers of hazardous places. Wakayama has 18,487 places, 3.5 % of the total, and is ranked as the sixth out of 47 prefectures (Table 12.7). On the other hand, there are 367,455 warning areas and 214,633 special warning areas for sediment-related disasters across the country, as of December 31, 2014. Wakayama designates 5927 warning areas and 3208 special warning areas and is ranked as the 24th (Table 12.8). Twenty-five municipalities in Wakayama, out of the total 30, have designated warning areas, while five municipalities of Hashimoto, Gobo, Yuasa, Hirokawa, and Kamitonda have not been designated yet. Tanabe city, Aridagawa town, and Kimino town are ranked as the top three municipalities with the most numbers of the warning areas. On the other hand, Aridagawa town, Kimino town, and Wakayama city have most numbers of the special warning areas (Wakayama Prefecture 2014).

Table 12.8 The status of designation of yellow zone and red zone by prefecture (As of December 31, 2014)

Rank	Name of prefecture	Debris flows		Slope failure		Landslides		Total		Share (%)	
		Yellow	Red	Yellow	Red	Yellow	Red	Yellow	Red	Yellow	Red
1	Shimane	13,191	(240)	18,211	(672)	621	(0)	32,023	(912)	8.7 %	0.4 %
2	Yamaguchi	9801	(2942)	14,550	(4086)	328	(0)	24,679	(7028)	6.7 %	3.3 %
3	Nagano	6258	(5164)	16,052	(13,468)	427	(0)	22,737	(18,632)	6.2 %	8.7 %
24	**Wakayama**	**1815**	**(898)**	**3973**	**(2310)**	**139**	**(0)**	**5927**	**(3208)**	**1.6 %**	**1.5 %**
	All prefectures	**128,921**	**(66,785)**	**232,888**	**(147,847)**	**5646**	**(1)**	**367,455**	**(214,633)**	**100 %**	**100 %**

Source: Prepared by Authors from MLIT (2014)

12.6 Discussion

12.6.1 Complexity of Land Use Zoning and Its Institutional Issues

As mentioned above, there are various types of land use zoning in terms of disaster risk reduction, based on different laws, including the Erosion Control Act, the Landslide Prevention Act, the Act on Prevention of Disasters Caused by Steep Slope Failure the Act on Sediment Disaster Countermeasures, the Building Standards Act, the Act on Regulation of Residential Land Development, and the City Planning Act. In most cases, land use zoning has been discretely designated based on each law. For instance, the City Planning Act designates the urbanization promotion area and the urbanization control area. In terms of disaster risk reduction, a criterion of demarcation between the urbanization promotion area and the urbanization control area is that an area is vulnerable to floods, tsunamis, and storm surges. An area vulnerable to sediment disasters, such as debris flows, slope failure, and landslides, is not clearly regarded in the criterion. Consequently, a gap arises between the urbanization control area under the City Planning Act and warning and special warning areas for sediment-related disasters under the Act on Sediment Disaster Countermeasures. This results in confusion and bottlenecks to clearly designate warning and special warning areas for sediment-related disasters, and there is a need to adequately coordinate among various types of land use zoning. On the other hand, there is a case that land use zoning has been designated in an integrated manner. For instance, the disaster hazard area under the Building Standards Act has been designated in conjunction with the steep slope landslide hazard area under the Act on Prevention of Disasters Caused by Steep Slope Failure (Yagi 2007).

Furthermore, the Sediment Control Division of Wakayama Prefecture is involved in managing baseline surveys and designation of the warning and special warning areas for sediment-related disasters. There are also other concerned divisions and departments across various areas, including city planning, agriculture, forest, natural park and nature conservation, building and housing, and disaster risk reduction. However, challenges include that each division solely works without adequate coordination (NILIM n.d.). Therefore, its Sediment Control Division is required to coordinate more closely with various divisions and departments.

12.6.2 The Need for Expeditious Designation of the Warning Areas

The land use zoning, in particular, clear and speedy designation of the hazardous places as warning and special warning areas for sediment-related disasters, is essential to inhibit inhabitation at sediment hazardous places. Until the end of 2010, the warning areas and special warning areas in Wakayama were less designated with

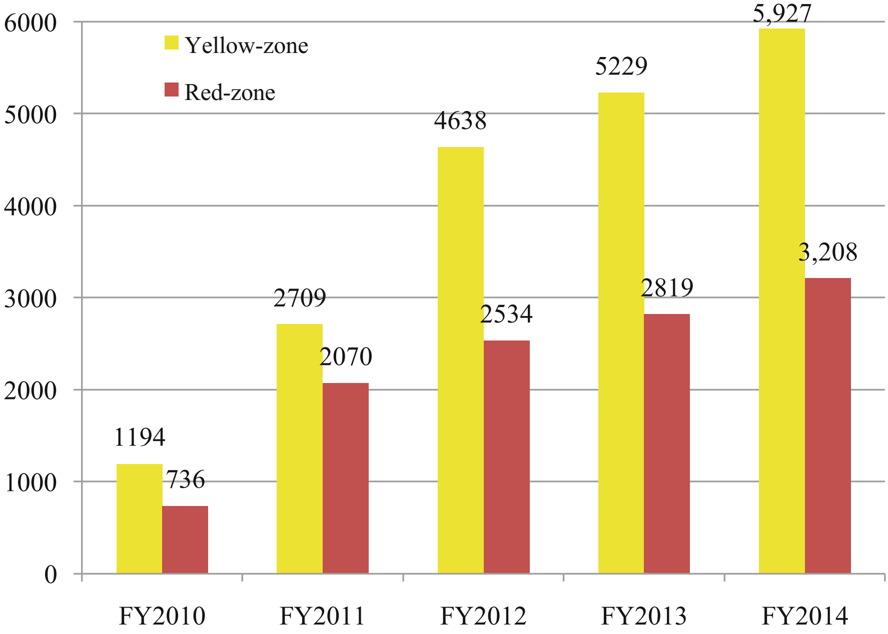

Fig. 12.7 Designation of sediment-related disaster warning and special warning areas in Wakayama (Source: Prepared by Authors from Kii Minpou 2014)

Table 12.9 The ratio of sediment-related disaster warning areas to sediment hazardous places in Wakayama

Name of prefecture	Designated places prone to sediment disasters	Yellow zones	Share (%)
Wakayama	18,487	5927	32.1 %
All prefectures	525,307	367,455	70.0 %

Source: Prepared by Authors from Tables 12.7 and 12.8

1194 and 736 for each. In the meanwhile, Typhoon No. 12 in 2011 raised public awareness on disaster risk reduction and accelerated the designation. Thus, at the end of 2014, the numbers of the designation on the warning and special warring areas were 5927 and 3208 for each (Fig. 12.7).

However, it is still not sufficient since there are 18,487 sediment hazardous places in Wakayama, while only 5927 warning areas have been designated. The ratio of the warning areas to the sediment hazardous places is 32.1 % (Table 12.9). This is very low compared to 70 % as the average of all prefectures. In addition, the warning areas are designated as a priority to the highest-risk sediment disaster places. As a result, some municipalities with many sediment hazardous places, such as Kamitonda town which has 497 places, have not yet been designated with the warning areas. Therefore, it is necessary for Wakayama Prefecture to accelerate the designation in order to secure residents' lives and health from sediment disasters.

12.6.3 The Need for Consensus Building with Residents

To promote land use zoning for Wakayama Prefecture, adequate consensus building with residents is an underlying assumption. The 2011 Typhoon No. 12 caused sediment disasters with the dead and missing at 13 locations in Wakayama, Mie, and Nara. The only one location was designated as the warning area (MLIT 2013). What causes make the progress of the designation delayed? The MLIT conducted a questionnaire survey about the warning area to prefectural and municipal governments in 2010 and 2011 (MLIT 2012). Regarding the question about the reason why the baseline surveys to designate the warning area have been delayed, 26 % respondents answered that the reason is because it takes time to explain to residents and respond to opposition by them. Thirteen percent of respondents answered that it takes time to consult with municipalities and respond to opposition by them. Meanwhile, 26 % respondents answered that it is difficult to secure the budget. It is pointed out that the main reasons for opposition by residents are because they are concerned about a decline in land prices due to designation of the warning area and also they complain about the regulations on building structures. On the other hand, the chief reasons for opposition by municipalities are because residents oppose to the designation and also municipalities are worried about depopulation. Therefore, it is imperative for municipalities in Wakayama to spend a series of in-depth explanations and consensus building with residents about the need of the designation and the measures to be taken after the designation.

12.6.4 The Need for Timely Warning and Evacuation System

Besides adequate land use zoning, it is also necessary for municipalities in Wakayama to issue evacuation instruction and recommendation for sediment disasters on a timely basis in order for residents to promptly evacuate when the disasters occur. According to the MLIT questionnaire survey, out of municipalities where the warning areas have been designated, only 53 % municipalities define specific standards to determine whether evacuation recommendation should be announced, such as information that indicates the urgency of precipitation and sediment disasters. Besides that, only 22 % municipalities prepare specific standards to determine which areas evacuation recommendation should be announced (MLIT 2012). At the abovementioned 13 locations where the 2011 Typhoon No. 12 caused sediment disasters with the dead and missing, the sediment disaster warning information was announced at all the locations. However, the evacuation instruction and recommendation were not issued at all. The other issue is that evacuation center may be located within the warning area where there is no enough space to establish a secure evacuation center due to extensive forest area.

12.6.5 The Need for Hazard Map of Sediment Disasters

As long as some residents live in land use zoning areas, such as sediment hazardous places and the warning areas, they may have to accept some extent of risk. On the other hand, in order for residents to promptly evacuate when sediment disasters occur, they must be informed about where the disasters are predicted to occur and where residents can evacuate to. Thus, dissemination of information by using a hazard map of sediment disasters in land use zoning areas is critical. Out of 1017 municipalities where the warning areas have been designated, only the 423 municipalities have published through distribution of a printed hazard map of sediment disasters (MLIT 2012). However, the 42 % dissemination rate of the hazard map is still low. It is highlighted that the central reasons why the hazard map has not yet been prepared are because municipalities face a shortage of manpower and budget. Therefore, it is important for central governments and the Wakayama prefectural government to support municipalities in securing sufficient manpower and budgets.

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Chapter 13
Uttarakhand Disaster and Land Use Policy Changes

Genta Nakano, Piyoosh Rautela, and Rajib Shaw

Abstract The state of Uttarakhand is located in the middle portion of the Himalayan mountain range that is prone to a number of hazards. It falls in major pilgrimage circuit of India and, besides Hindu holy townships of Haridwar and Rishikesh, houses Badrinath, Kedarnath, Gangotri, and Yamunotri shrines of Hindus, Hemkund Sahib and Reetha Sahib of Sikhs, and Kaliyar Sharif of Muslims. The state at the same time has a number of tourist destinations and flourishing adventure sports industry. Together, these attract people in large numbers. Land use/cover changes around the areas of Nainital that witnessed high tourist pressure were thus studied. Unplanned constructions, encroachments, and blockade of surface drainage are observed to pose a serious threat to the stability of the hill slopes in Nainital. Land use/cover change studies can help in better developmental planning and in keeping identified vulnerable areas, particularly in the proximity of rivers and in the recharge zone of water bodies, free from human intervention. These would at the same time help in better monitoring of the developmental initiatives.

Keywords Land use • Uttarakhand • Human intervention

13.1 Introduction

The state of Uttarakhand is located in the middle portion of the Himalayan mountain range, and it falls in the latitude of 28°43′ N to 31°27′ N and longitude of 77°34′ E to 81°02′ E. The state shares an eastern frontier with Nepal, northern with

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Tibet and with Himachal Pradesh, and Uttar Pradesh in the south and west, respectively (Fig. 13.1). The state was carved out of the northern mountainous portion of Uttar Pradesh in 2000 as the 27th state of the Republic of India. The state is divided into two divisions, Garhwal and Kumaun, and consists of 13 districts. Garhwal division includes districts of Pauri Garhwal, Tehri Garhwal, Chamoli, Haridwar, Dehradun, Uttarkashi, and Rudraprayag, while the districts of Almora, Bageshwar, Champawat, Nainital, Udham Singh Nagar, and Pithoragarh fall in the Kumaun division. It has the population of 10.1 million with the population density of 189 per square km. This density is much less than the Indian national average of 382 persons per square km. Like other states of India, Uttarakhand is facing fast population growth. Decadal growth rate between 2001 and 2011 being 19.17 % is slightly higher than the national average of 17.64 % (Census of India 2011).

The state of Uttarakhand falls in the major pilgrimage circuit of India and, besides Hindu holy townships of Haridwar and Rishikesh, houses Badrinath, Kedarnath, Gangotri, and Yamunotri shrines of Hindus, Hemkund Sahib and Reetha Sahib of Sikhs, and Kaliyar Sharif of Muslims. Most of these are located in the Higher Himalayas. The state at the same time has a number of tourist destinations that include Auli, Mussoorie, Nainital, Kausani, and Munsiyari. The adventure sports industry of the state also attracts people in large numbers. The state thus has a large floating population and faces high anthropogenic pressure, particularly during the summers when people from across the country and abroad visit the state.

Uttarakhand is also known as a multi-hazard-prone state. The collision of Indian and Eurasian plates produced the Himalayan mountains. Tectonic history together with high relative relief and seasonal precipitation makes this region prone to a number of hazards. The Indian plate is moving toward northeast with the convergence rate of 55 mm per year. Himalayan terrain has thus experienced a number of major earthquakes in the past that include Kumaun earthquake of 1720, Garhwal earthquake of 1803, Shillong earthquake of 1897, Kangra earthquake of 1905, Bihar-Nepal earthquake of 1934, and Eastern Assam (Arunachal) earthquake of 1950. In the recent past, Uttarakhand has witnessed the Uttarkashi earthquake of 1991 and Chamoli earthquake of 1999. The Uttarkashi earthquake killed 768 people and fully devastated 20,242 houses, while the Chamoli earthquake killed 106 and 14,727 houses were totally destroyed.

Apart from seismic risk, landslides, cloudburst, and floods frequently induce disasters in the state, especially during the monsoon period. High intensity rainfall in 2013 that was 375 % above the daily average of monsoon season (Dube 2014) invited flash flood and landslide in various parts of the state. It occurred during the pilgrimage season, and most deaths were from among pilgrims and those involved in the service industry. Unplanned and unrestricted tourism development has been the cause of increased vulnerability of the area.

It is important to study the land use/cover change of the state to monitor the changes therein and identify the vulnerability. As land use/cover change is dynamic, it is alternated because of a lot of factors such as climatic, hydrological, and geological conditions as well as human activities such as construction and agriculture. The term of land cover basically stands for the vegetation or man-made physical properties, while land use represents the human activities taking place on the surface of the land.

Fig. 13.1 Map of Uttarakhand, India (Partially added by author to the map of Census of India 2011)

This chapter explains that study of the land use/cover change can help in better planning and in keeping identified vulnerable areas, particularly in the proximity of rivers and in the recharge zone of water bodies, free from human intervention. This chapter includes the case study of Nainital town, which is facing the problem of conversion of forest area into built-up environment due to the fast-growing tourism industry.

13.2 Description of Land Use/Cover in Uttarakhand

The state has geographical area of 53,483 km^2 and 93 % of the total area (46,035 km^2) is hilly, while 64 % (34,651 km^2) is covered with forest. Altitudinal range of the state starts from 200 m and reaches up to 8000 m above mean sea level, and thus the state is mountainous with steep slope. Marginal altitude of human habitation is around 3500 m above mean sea level and 28 % of state's territory is above 3000 m. Livelihood of people is dependent more on the mixed practice of farming, forestry, horticulture, and livestock rearing. In spite of its mountainous feature, the agricultural land occupies 21.72 %, and it consists of 13.99 % of crop land, 7.30 % of current fallow, and 0.43 % of plantation. Agriculture in Uttarakhand can be divided into two types: rain fed and irrigation. 90 % of the irrigated agricultural land is used for growing cereals. The other feature of agriculture in terms of the land is the form of land ownership. Distinguishing from the rest of the nation, the majority of the farmers own their farmland, and tenant farming and share cropping are not practiced. Uttarakhand is thus an agricultural state and agriculture contributes 22.41 % of domestic product, and 75–85 % of the population depends on agriculture for livelihood (DMMC 2014). On the other hand, 33 % of the land is uncultivable because it is covered by snow or glacier and rocks. Agricultural productivity in the state is observed to depend on the geographical features. The productivity of the hilly area is lower than the plain area and the following are some examples (Government of Uttarakhand 2012). In the plain areas such as Udham Singh Nagar, Haridwar, plain area of Nainital, and plain area of Dehradun, the productivity of rice is 23 q/ha and of wheat is 33 q/ha, while the hilly areas produce 13 q/ha of rice and 12 q/ha of wheat. One of the reasons of this difference is that the agriculture of the plain areas is more commercialized and utilizes chemical fertilizer, leading to high productivity.

Figure 13.2 and Table 13.1 show the land use pattern of the Uttarakhand state. The state is abundant in the natural resources as 61.91 % is covered by forest. However, the state now faces the degradation of natural resources as the decrease of the forest area is significant. Kala (2014) indicated that 44,868 ha of forest has decreased since 1980. 9500 ha has been converted into roads, 5500 ha is deforested for hydropower projects, and 3100 ha is converted for transmission lines. In fact, the 68 % of this conversion has taken place after 2000. These human interventions are mostly for creating basic infrastructure that is required for the well-being of people, and its pace is to go up with increasing population pressure and inflow of tourists in the region.

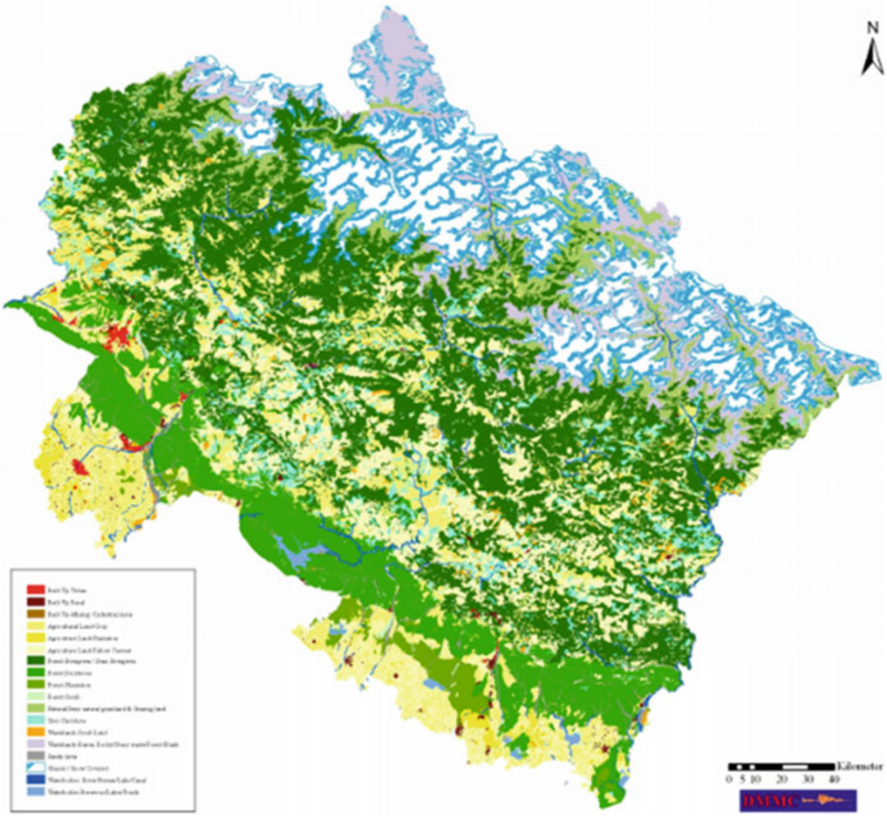

Fig. 13.2 Land use/cover map of Uttarakhand (DMMC 2014)

The Constitution of India prescribes land use management to be a state subject, and the Twelfth Five Year Plan 2012–2017 of the Government of India called for state governments to establish state-level land use plans (Planning Commission 2012). Land ownership is one of the issues in land use management. For example, a large portion of forest area of the state is owned and managed by different organizations such as Forest Department, Revenue Department, panchayat, and military (Wakeel et al. 2005). Individual ownership being limited to development and conservation of land depends on the decision of the agencies. However, there is no clear demarcation of responsibility of land use planning (Government of Uttarakhand 2007), and thus the state land use plan needs to be formulated with inputs from Disaster Management Department.

Due to this institutional setting, forest degradation is induced, and it results in decline of water holding capacity implying water shortage in the dry season and increased surface runoff during the monsoon period. As the mountain does not absorb the rainwater, this accelerates the soil erosion and the slope becomes more vulnerable. Direct inflow of surface water to the river and instable slope enhance

Table 13.1 Land use pattern of the state of Uttarakhand (DMMC 2014)

Land use type	Area (sq km)	Percentage
Agricultural land; crop land	7466.58	13.99
Agricultural land; current fallow	3896.00	7.30
Agricultural land; plantation	227.14	0.43
Built-up area/mining/industrial area	6.57	0.01
Built-up area; rural	202.76	0.38
Built-up area; urban	126.11	0.24
Forest; barren land	3864.80	7.24
Forest; dense	14,706.91	27.56
Forest; open	8709.55	16.32
Forest; plantation	775.84	1.45
Forest; scrub	4982.30	9.34
Glacial area	7327.36	13.73
Water bodies; river/stream/lake/pond (perennial)	875.32	1.64
Water bodies; canal	18.51	0.03
Water bodies; reservoir	173.51	0.33
Total	**53,359.24**	**100.00**

the risk of flash flood and landslide. The mountains thus become more prone to natural disasters.

The development of infrastructure and deforestation is interrelated with the increase of tourists as mentioned earlier. According to the statistics in the year of 2000, 11 million people visited the state. However, it increased to 31 million people in the year 2010 (Department of Tourism 2011). The tourism industry itself is very influential to the land use/cover change because, in addition to the development of basic infrastructure such as roads, electricity generation plants, and transmission lines, it requires construction of accommodation and other facilities. Hotel at riverside and water-related attractions tend to attract more people; therefore the facilities are more concentrated in the proximity of the riverside. These developmental initiatives however do not include the viewpoint of disaster management, and this kind of unplanned infrastructure makes the land even more vulnerable. Increasing demand of the tourism, followed by the investment to the service industries and unplanned development, is the main factor of enhancing the vulnerability in the state.

13.3 Disasters in Uttarakhand

As mentioned above, the state of Uttarakhand is experiencing the land use/cover change especially due to the human intervention with the environment. The human intervention is accelerated by the development of roads and construction of basic facilities for human living such as electricity generation plants and transmission lines followed by the increasing number of tourists. These anthropogenic interventions enhance the vulnerability of the area; thus, the state of Uttarakhand became more prone to natural disasters.

13.3.1 Recent Disasters in Uttarakhand

Uttarakhand is a multi-hazard-prone state which is routinely affected by frequent hydrometeorological disasters especially during the monsoon period. These include drought of 2008 and 2009 and landslides and flash floods of 2010, 2012, and 2013. The state is also seismically vulnerable and affected by the Uttarkashi earthquake in 1991 and Chamoli earthquake in 1999.

Land use/cover change especially from the forest to the built-up area contributes to make the damage more serious in the recent disasters of the state. In August 4, 2012, the district of Uttarkashi received a rainfall of more than 70 mm a day, and the water level of Bhagirathi river went up to 4 m above the danger level (DMMC 2012). This induced a serious impact along the river, 29 people were washed off, and bridges, roads, and other public infrastructure as well as properties were severely damaged. Morphology had indicated that this level of disaster was not an abnormal phenomenon since it had been observed before. Therefore, this serious impact is attributed to construction in the proximity of the riverfront. This kind of unplanned development in the vulnerable land is still observed along the river, and actually there is no legal framework to regulate the development close to the river.

Another recent example was known as the Kedarnath tragedy. Between June 13 and June 19, 2013, the state of Uttarakhand received an unusual rainfall which was 292 % and 1436 % more than the usual precipitation of average rainfall of the last 30 years (Negi 2014). This extreme rainfall especially affected the Mandakini valley in Rudraprayag district, and flash flood and huge landslides were induced. Official records suggest that more than 4000 people were killed and most of these are still missing. One of the factors of serious impact was the tourism industry close to the riverfront. The Rudraprayag district housing the Hindu holy shrine of Kedarnath is well known in the pilgrimage circuit, and due to a growing number of tourists, unplanned development has been going on for years: road construction, multistory hotels along the river, hydroelectric projects, and the like. Most of the victims were pilgrims or those who worked for service industries.

Apart from these disasters, the road network in the mountainous region of Uttarakhand is always affected by the rockfall and small-scale landslide. This impeded usual traffics as well as the smooth rescue operations both in 2012 Uttarkashi flood and 2013 Rudraprayag flood and landslides. The method of road construction in the state is one of the factors for increasing the instability of the slope. Moreover the road is constructed on the middle of the mountain, and the dynamite is used to cut the construction cost. Therefore the land section has no more vegetation and easily gets weathered due to precipitation and wind. Thus, the slope along with the road remains vulnerable.

13.3.2 Lessons Learnt from Past Disasters

In case of both the 2012 flood in Uttarkashi and 2013 flood and landslide in Rudraprayag, unplanned human intervention was the biggest factor for making the damage more serious. The study on land use/cover change is required to identify the area more vulnerable, and the result of the study should be incorporated into the development plan of the district. In terms of the legal framework, actually there had been no regulation to control the development along with the river at state level. However, soon after the 2013 flood, the state has banned the new construction within 200 m from the riverfront. This kind of uniformed regulation might be useful to regulate the new construction, and on the other hand, the regulation should be more location specific since the land use pattern and natural environment are different from place to place.

At the same time, not only the human intervention of the proximity to the river, Kala (2014) pointed out that the deforestation was a major factor of Kedarnath disaster. Although Negi (2014) denies the opinion that deforestation was the principal cause of the 2013 disaster, the tendency of deforestation should be taken into consideration for the analysis of risk. Forests retard surface runoff and prevent the water from flowing quickly into the river; thus, it controls the water level of river. In addition, trees prevent soil erosion and thus contribute positively toward land stability. The study of land use/cover change can reveal also the change of forest cover; thus, the vulnerability can be identified.

Therefore, the Uttarakhand experiences of disasters indicate that the study of land use/cover change is important because it helps in understanding anthropogenic intervention in the area and its vulnerability to natural hazards. The study of conversion from the natural environment to built environment as well as deforestation should be fully incorporated into the development plan and further appropriate regulation.

13.4 Case Study of Land Use/Cover Change in Nainital

The human intervention to the land has actually contributed to enhanced vulnerability, and investigation of the land use/cover pattern should be taken note of while preparing development plans and mainstreaming disaster management. Hence this section provides the case of Nainital to make good use of the lessons learned from past disasters.

13.4.1 Introduction of Nainital

The district of Nainital is located in the eastern part of the state in the Kumaun division, and the Naini lake is situated at the center of the township of Nainital (Fig. 13.3). This district has many attractions for tourists such as yachting, boating,

Fig. 13.3 Figure view of Naini lake (Photo provided by DMMC)

horse riding, hiking, ropeway, and religious places. One of the Hindu religious texts mentions about the Naini lake, and it is believed that those who take a bath in the lake can be led to Heaven of Lord Brahma, while those who drink the water of the lake can go to the paradise of Lord Shiva. In fact, the name Naini came from the temple of the goddess close to the lakeside. The temple was devastated due to the landslide in 1880; however, it was reconstructed lately in a different place.

In terms of geography, Deopatha hill which rises up to the level of 2435.1 m above mean sea level is situated in the western part of the town, and on the south the Ayarpatha hill reaches up to 2274.1 m above mean sea level. These hills gradually decrease in altitude toward the east where the Naini lake is situated at the altitude of approximately 1935 m. Nainital has its geographical area of 4251 km^2 with the population of 954,605 (DMMC 2011). The average summer temperature is around 25 °C and temperature drops up to 0°°C in the winter time.

The development of the Nainital area started as a summer destination in the era of British Raj, and it soon became a popular resort especially for those who came from Britain. The beautifulness of the lake and pleasant climate accelerated the development, and it is recorded that 40 houses were constructed at Nainital and 61 people spent the summer between March and August 1847. Nainital has been constituted as the municipality in 1873 administrated by a committee of six members, and at the moment the Nainital became the English health resort and Indian nationalities migrated for service industries. The population of Nainital was 7609 in 1901. However, the British government started to provide subsidies to British civil servants to take the vacation in England in 1925, and hence the number of the visitors to Nainital witnessed a decline, and soon proportion of Indian population grew

Table 13.2 Socioeconomically significant landslides since 1880 in the Nainital district (Parkash 2011)

Month/year	Impact
July 12, 2013	Six killed
September 18, 2010	Eight killed
July 20, 2010	One killed
September 28, 2008	One killed and three injured
1963	Damage to road and houses
September 18, 1880	Massive destruction, killed >150 persons

in the area (DMMC 2011). Even though Nainital has not witnessed strong seismic activity in the past hundreds of years, the district falls in the zone IV of Earthquake Zoning Map of India and also has been affected by the monsoon rainfall as other places in the state. Thus, the Nainital town has high potential for natural disasters. Table 13.2 shows the socioeconomically significant landslide recorded in the area of Nainital.

13.4.2 Land Use/Cover Change in Nainital

According to the investigation (Rautela 2014) conducted by the Disaster Mitigation and Management Centre of Government of Uttarakhand utilizing the high-resolution multispectral 8-band WorldView-2 (WV2) satellite imagery as of December 24, 2010, the land use/cover of Nainital has been classified into seven categories: dense forest, open forest, trees out of forest, water bodies, open area, agriculture, and urban/built-up area. Nainital is mostly covered by the dense forest occupying the 62.41 % of total area and 22.68 % of open forest (Table 13.3). On the other hand, the built-up area holds only 5.29 %, and it concentrated at surroundings of the northwest and southeast edge of Naini lake.

The gradient and aspects of slope generally has the correlation with the land cover pattern (Table 13.4). For example, the excessive exposure to the sunlight on certain slope aspect promotes the evaporation of the land moisture, and it might even affect the nutrition cycle of the soil. At the same time, the precipitation and the gradient of slope also affect the coverage. Hence the steepness and the aspects are important components to influence the land cover. The study shows most of the forest cover is observed up to the area of 50° and more concentrated in the moderately steep area as 32.46 % of dense forest and 37.58 % of open forest are accounted for. Human settlement is mainly observed in the gentle area, and it holds 45.34 %, and people prefer to live in the less steep area as 93 % of built-up area is situated below 35°.

Table 13.3 Land use/cover of Nainital as of December 24, 2010 (DMMC 2011)

Land use/cover class	Area (in square meters)	Percent of the total
Built-up area	926,982.07	5.29
Open area	235,067.78	1.34
Trees out of forest	704,877.81	4.02
Open forest	3,973,041.66	22.68
Dense forest	10,934,723.86	62.41
Agriculture	279,058.03	1.59
Water bodies	467,488.30	2.67
Total	1,7521,239.51	100.00

Table 13.4 Variation of land use/cover with surface slope in Nainital (Rautela et al. 2014)

Land use/cover class	Area (in percent)				
	Gentle (0–15°)	Moderate (15–25°)	Moderately steep (25–35°)	Steep (35–50°)	Escarpment (> 50°)
Dense forest	21.08	25.38	32.46	20.29	0.78
Open forest	10.74	24.24	37.58	25.22	2.48
Trees out of forest	29.75	34.50	25.44	10.31	0.00
Built-up area	45.34	29.12	18.57	6.95	0.02
Open area	54.48	21.98	11.28	11.90	0.36
Agriculture	47.74	35.84	10.16	6.26	0.00

The characteristics of land use/cover change have been analyzed between January 2005 and December 2010. For both studies, high-resolution QuickBird Pan satellite imagery was utilized (60 and 50 cm resolution for 2005 and 2010, respectively) (Rautela 2014), and its result is shown in table 13.5 and figure 13.4. According to the data, the built-up area has increased 33.88 % between 2005 and 2010 which is equivalent to the increase of 213,609.94 m^2. Most of the built-up area was converted from trees out of forests which decrease 43.72 % (Table 13.5, Fig. 13.4). Agricultural land was relatively small in 2005, and its area has been shrinking even smaller by 30.17 % in 2010. 213,609 m^2 has been replaced in 6 years from forest area, and this date implies that built-up area is expanding on an average of 3500 m^2 as anthropogenic intervention.

13.4.3 Analysis on Anthropogenic Intervention at the Area

Comparative study of land use/cover change between 2005 and 2010 revealed that the forest area has been replaced by built-up area by 33 %. Thus, its anthropogenic pressure is clearly observed in the area. Population growth can be one of the reasons of increasing built-up area, and it has been increasing from 39,911 people in 2001

Table 13.5 Statistical details of changing land use/cover characteristics at Nainital (Rautela et al. 2014)

	Area (in square meters)			
	QuickBird	WV2	Change in area	
Land use/cover class	(January 5, 2005)	(December 24, 2010)	(WV2-QB)	Percent change
Built-up area	630,498.18	844,108.12	213,609.94	33.88
Open area	345,878.41	208,344.41	−13,7534.00	−39.76
Trees out of forest	1,242,649.75	699,390.98	−543,258.77	−43.72
Open forest	2,143,476.85	2,661,936.97	518,460.12	24.19
Dense forest	7,789,118.89	7,746,524.83	−42,594.06	−0.55
Agriculture	34,849.72	24,333.99	−10,515.74	−30.17
Water bodies	441,331.48	443,164.00	1832.52	0.42
Total	12627803.29	12,627,803.29	–	–

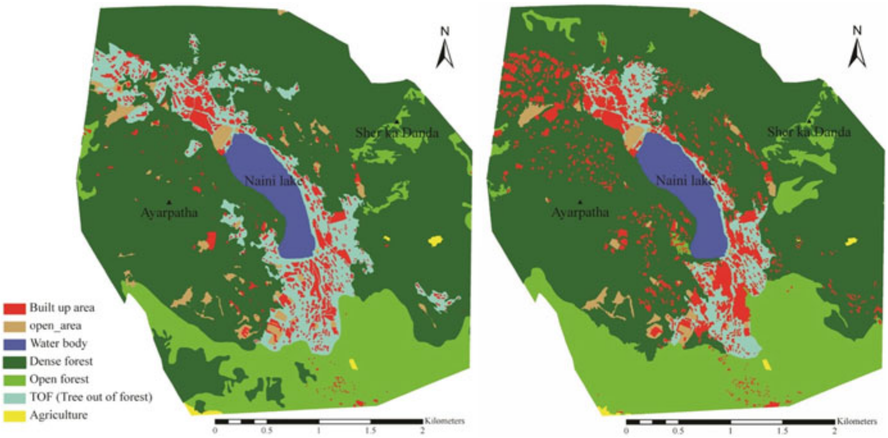

Fig. 13.4 Map depicting land use/cover characteristics around Nainital in 2005 (*left*) and in 2010 (*right*) (DMMC 2011)

to 41,461 people in 2011. However, the population has grown only by 1550 people, and its growth rate is approximately 4 %, which is much less than the state average rate. Hence the increase of built-up area is possibly due to the development of tourism industry as it is considered that there are many floating population since Nainital has a lot of tourist destinations. Furthermore, according to the Census of India 2001, the population of the slum area in Nainital has nearly 10,000 people, and this is equivalent to almost one-fourth of total population of Nainital. Especially these slums are formed in the most vulnerable part of the town, and the growing informal settlement can be another factor of conversion into built-up area.

Fig. 13.5 View of indiscriminate disposal of excavated material along the hill slope (DMMC 2011)

Construction of houses and basic infrastructure resulted in the slope modification and undercutting. Many parts of steep slope were observed to be excavated, and inappropriate excavation makes the slope unstable and raises the risk of landslides and rockfall. Furthermore the excavated materials are dumped off indiscriminately at the convenience of construction workers (Fig. 13.5). Most of the materials are disposed off along with the slope and it hampers drains. At the same time, the local government and residents do not put any emphasis on the management of drainage water, and many of the drainage networks in the municipality were thus encroached, blocked, and even destroyed at many parts (Fig. 13.6). Surface drainage should be functional for the safe disposal of rainwater. Unplanned drainage and inappropriate water management can generate adverse impact upon hydrological regime of the area and affect the vulnerability of the slope.

Naini lake, which is a tourism resource as well as a source of economic benefit for local people, is facing the risk of losing its value due to human intervention. The encroachment to the recharge zone causes actual decrease of the level of Naini lake. The lake level in March 15, 2003 was 9.26 ft, and it shows the tendency of decreasing to 7.77 ft in 2005, 6.85 ft in 2007, 6.20 ft in 2009, and 3.95 in 2011. The clay and silt layers are the important soil profiles for slowing discharge from the reserves, and they ensure the gradual recharge to the lake. Hence the soil should not have intervened with the construction and any other way. The decrease of the forest area at the same time can accelerate this tendency because of the lesser capacity of holding water in the area.

Fig. 13.6 Blockade of drainage by construction (DMMC 2011)

In the case of Nainital, regulation of anthropogenic activity started rather early, and it is owed largely to the devastating landslide of 1880. The committee constituted to investigate the causes of the landslide suggested measures for setting right the state of things, suggested seepage of rainwater into the hillside as the major cause of landslide, and made detailed recommendations in 1880. The committee recommended that all ravines be lined with side walls and paved flooring be provided in these, platforms around houses be made impervious, gardens and cultivated terraces be developed together with quarrying, and all household wastewater be drained into paved ravines. Action was initiated on these recommendations.

In accordance with United Provinces Municipalities Act of 1916, bylaws were put in place in 1930 for ensuring safety of the hill slopes and regulating construction of buildings in Nainital. These were revised from time to time, at present building bylaws notified in 2011 are in force, and the Nainital Development Authority is responsible for ensuring construction in accordance with the same in Nainital City and surrounding areas.

However, the land use/cover change of these 6 years between 2005 and 2010 was observed especially in the prohibited area. The built-up area has been increased 51.2 % within the prohibited area, and this goes above the average increase rate of 34 % (DMMC 2011). The Supreme Court of India in 1995 has indicated the needs of regulation of construction activities in certain areas in terms of avoiding the new construction at vulnerable slope in Nainital; compliance of it is a gray area. Thus, the implementation of regulations with the viewpoint of disaster risk reduction is one of the institutional issues at the district.

Unstable slope can enhance the damage due to the seismic activities. Even though the district has not experienced major seismic activity for a long time, Nainital falls in zone IV and V of the Seismic Zoning Map of India, a study at Nainital (DMMC 2010) revealed that constructions at Nainital do not take into consideration the strong earthquake activities; hence, adequate countermeasures such as the adequate application of building code also should be considered.

In the case of Nainital, encroachment of recharge zone and unplanned and inappropriate development of infrastructures enhance its vulnerability to both landslide and earthquake. These facts suggest immediate need of having a development policy that reduces the vulnerability of the population to hazards. In addition, the state government officially declared the ban of construction within 200 m from the river; however, further legislative measures are to be taken for prohibiting human intervention at the vulnerable area.

13.5 Conclusion

The state of land use/cover changes in the areas of Nainital in the Lesser Himalayas that witnessed high tourist pressure was thus studied for the time period of 2005 and 2010. Anthropogenic intervention especially due to the investment to the tourism sector with the increasing number of tourist accelerated the land use/cover change from forest to the built environment. Unplanned construction, encroachments in the catchment of the Naini lake, and blockade of surface drainage network were observed to pose a serious threat to the stability of the hill slopes and also the existence of the lake itself. The same was reflected in the dwindling lake levels. In addition, Nainital falls in zone IV of Earthquake Zoning Map of India, and therefore there is an urgent need for the enforcement of building codes. Lessons learnt from the previous disasters and present situation of Nainital suggest immediate need of having a development policy that reduces the vulnerability of the population to various hazards, and further legislative measures and its secure implementation are to be taken. Land use/cover change studies can help in better planning of these initiatives and in keeping identified vulnerable areas, particularly in the proximity of rivers and in the recharge zone of water bodies, free from human intervention. These would at the same time help in better monitoring of the developmental initiatives.

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Chapter 14
Climate Change and Its Impacts on Land Use/Cover Change and Food Security in Nepal

Shobha Poudel and Rajib Shaw

Abstract Nepal is rich in natural resources, biodiversity, etc., but several of them are endangered; climate change, overexploitation, etc. could be the potential reasons. Several studies suggest that high-altitude areas are more vulnerable to climate change, and thus the majority of the mountainous regions in Nepal are in the extreme risk condition due to the adverse effect caused by climate change and global warming. The recent study shows that the average temperature is increased by 0.04 °C per year in the Terai and 0.08 °C per year in the Himalayas since 1980. It means the higher the altitude, the higher the increase in rate. Therefore, the mountain region is more vulnerable in comparison to the Terai plain area of Nepal. Although there is a contribution of climate change in the vegetation growth in the Higher Himalayas, most parts of the country are facing the adverse impact of climate change especially in the agricultural sector. Eventually, changing climate has an adverse effect on the land use and land cover along with the food security of the mountainous region. Nepal government is actively working to mitigate the adverse effects of climate change specially climate change-induced disasters and to ensure the proper use of the available land. Several land use policies have been formulated for the sustainable agricultural development and to preserve the ecosystem and biodiversity.

Keywords Climate change • Land use change • Food security • Mountainous region • Nepal

14.1 Introduction

Nepal, officially the Federal Democratic Republic of Nepal, is located between China, in the north, and India, in the south, east, and west. It is the mountainous and landlocked country covering 147,181 km^2 with the population of 26,494,504

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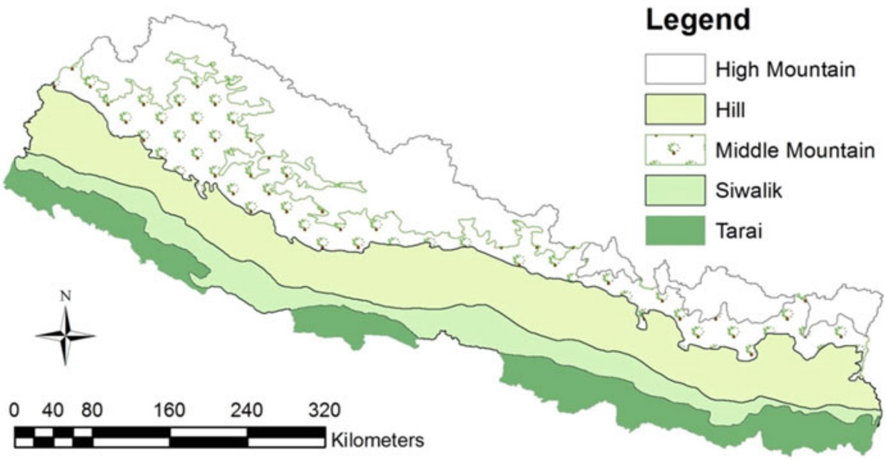

Fig. 14.1 Topography of Nepal (Source: Department of Survey, Government of Nepal)

(Census 2011). It extends from 26º 22′N to 30º 27′N and 80º40′ E to 88º12′E. Nepal is divided into three main geographical regions: high mountain, hill, and Terai. High mountain covers 35 % of total area, and hill or middle mountain and Terai cover 42 % and 23 %, respectively. Mt. Everest (8848 m) is the highest point in the country, which is the highest peak in the world as well, while the lowest point is in the Terai, named Kechana Kalan (70 m) in Jhapa District (DFRS and NFA 2008).

Nepal can be broadly divided into five ecological zones with respect to the altitude (Fig. 14.1): the tropical zone below 1000 m, the subtropical zone between 1000 and 2000 m, the temperate zone between 2000 and 3000 m, the Alpine zone between 3000 and 5000 m, and the Arctic zone above 5000 m (CBS 2013a). Similarly, Nepal experiences four distinct climatic seasons: spring/pre-monsoon (March–May), monsoon/summer (June–September), post-monsoon/autumn (October–November), and winter (December–February). The average rainfall is about 1800 mm per year (MoEnv 2010).

The mountain ecosystem of Nepal provides several important ecosystem goods and services such as habitat diversity and protection, water resources, food and fiber production, etc. Most of the mountain area's ecosystem is combined with natural components and components that have been modified by human activities, such as agriculture and forestry (Korner et al. 2005). Additionally, the mountain environment is fragile to change, such as land use dynamics which can have a large impact with the small changes in climatic and environmental factors in this region (Houet et al. 2010). The main agents of the environmental change in the mountainous area of Nepal are changes in land use pattern, climate change, rapid urbanization, and population dynamics. These agents have made the mountain people more vulnerable to economic and environmental aspects and threaten the livelihoods of rural households (Poudel and Shaw 2015). Changes in land cover from forest to other uses such as construction of buildings, roads, and agricultural activities have been

Fig. 14.2 Photograph of higher mountainous region of Nepal (Photo: Shobha Poudel)

widespread globally. Due to climatic and geographic conditions, most of the land is threatened by degradation and desertification. The snow cover area is decreasing regularly in the mountains (Mishra et al. 2014a), resulting in the depletion of water resources. Eventually, that leads to decrease in agricultural production and environmental degradation.

As the rangeland is increasing in the higher altitude, the livestock have to be moved to the higher elevations for grazing, affecting the lives of mountain people. The shortage of fuel for cooking is the prominent example. The shortage of fuel has forced people to use firewood that increases the stress to the forest. Water is another important resource affected by climate change. Access to safe drinking water is a big issue in the Nepalese Himalayas (Sherpa et al. 2010).

In the mountain region, the main occupation is agriculture on which more than 60 % population are dependent (CBS 2013a). However, production is very low that leads to food insecurity because of unavailability of irrigation, inadequate agriculture practices, insufficient arable land, and lack of agricultural infrastructures (Fig. 14.2). Food insecurity has further worsened due to the irregular weather pattern and increasing frequency of natural disasters like droughts, flashfloods, and landslides.

14.2 Present Status of Land Use Pattern in Nepal

Land is one of the most important sources of livelihoods for the human being and one of the most important natural resources where many development activities are dependent. Infrastructure development, rapid population growth with the growing demand of water resources, food, and agricultural land are creating pressure on the land resources in Nepal. Although Nepal has a large area of abandoned land, due to the lack of proper management (FAO 2010), there is a scarcity of cultivable land. According to the Central Bureau of Statistics of Nepal, in 2008 there was 0.6 ha land availability per household, while it was 0.8 ha in 2001 (DpNet 2013). Due to

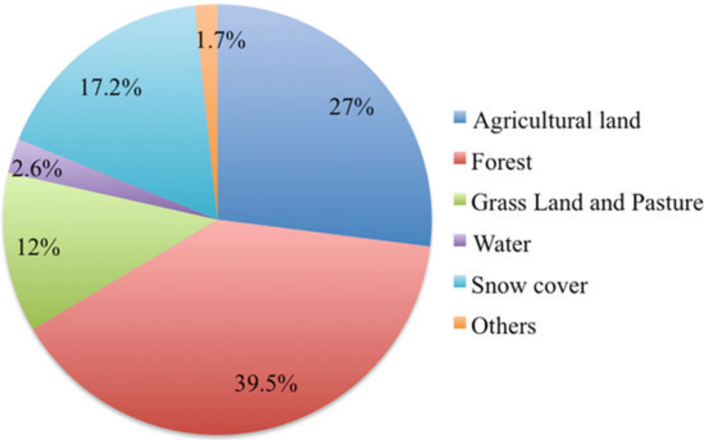

Fig. 14.3 Land use pattern of Nepal (MOLRM 2012; FAO 2010)

Table 14.1 Physiographic and bioclimatic zones of Nepal

Physiographic zone	Area (%)	Elevation (m)	Bioclimatic zone
High Himal	23	Above 5000	Arctic and tundra
High mountains	19	4000–5000	Alpine
		3000–4000	Subalpine
Middle mountains	29	2000–3000	Montane (temperate)
		1000–2000	Subtropical
Siwalik	15	500–1000	Tropical
Terai	14	Below 500	Tropical

Source: CBS (2013a, b)

the increasing population and occurrence of natural disasters, land availability of per capita is declining.

Nepal government has set out Land Use Policy 2012 that expects to control rapid urbanization and unplanned use of land. This land use policy may ensure the proper utilization of the land all over the country. But in the absence of effective acts to implement the policy, agricultural land is being used for nonagricultural purpose such as as a built-up area. Furthermore, encroachment of public land by the landless squatters and other individuals is also increasing notably.

Nepal is divided into three ecological regions, namely, Himal, mountain, and Terai; the hill and mountain regions cover over 70 % of the total land area. The highest population density per unit cultivated land is in the middle mountain region. Moreover, even the marginal areas with steep and very steep slopes have been encroached for agricultural purpose (Fig. 14.3, Tables 14.1, and 14.2). That leads to the overutilization of land and land degradation.

Table 14.2 Changes in land holding of Nepal in the last 30 years (1982–2012)

	Census year			
	1982	1992	2002	2012
Land use	('000 hectares)			
Agricultural land	2359.2	2392.9	2497.7	2363.09
Arable land	2287.50	2324.30	2357.00	2162.14
Land under temporary crops	2250.20	2284.70	2326.10	2123.17
Other arable land	37.3	39.7	30.9	38.97
Land under permanent crop	29.2	29.4	117.5	168.45
Land under permanent pastures crops	42.50	36.90	19.80	29.30
Ponds	n.a.	3.9	3.5	3.20
Nonagricultural land	104.50	205.00	156.40	161.91
Woodland and forest	15.00	108.80	37.20	54.89
Other land	89.5	96.2	119.2	107.02
Total area of holding	2463.70	2597.40	2654.00	2522.52

Source: CBS (2013b)

14.3 Climate Change and Land Use Pattern Changes in Nepal

Most parts of the world have experienced an increase in surface air temperature during the last century. Similarly changes in intensity and frequency of extreme weather conditions are common such as droughts, floods, storms, avalanches, etc., which lead to climate-induced disasters. According to Mishra (Mishra et al. 2014a) the seasonal temperature increased 0.04 °C per year and 0.08 °C per year in the Himalayas. Therefore, the mountain region of Nepal is highly vulnerable. In addition to that, due to the changing climatic patterns, land cover and use patterns are also likely to change in several parts.

As the land use pattern in the mountainous region of Nepal is highly vulnerable to the changing climate, changes in climatic factors may contribute to change a distribution of vegetation in subalpine and alpine regions. The snow cover area is also changing into grassland apparently in the Higher Himalayas region (Mishra et al. 2014a), while forest to other classes, such as agricultural land and built-up area, is common all over the hills and the Terai region. Rapid urbanization, global environmental change, population growth, and the necessity of an agricultural land are the major agents of such changes.

Figure 14.4 depicts that, although there is a variation in the temperature between 1975 and 2009, overall temperature is in an increasing trend. There was the average highest temperature in 2007, and in 1981 the average lowest temperature over the period of time. Similarly, the average rainfall of the country from 1971 to 2009 is shown Fig. 14.5 . There was minimum rainfall in 1992, while maximum rainfall was in 1971; however, the rainfall trend decreased slightly over the period of time.

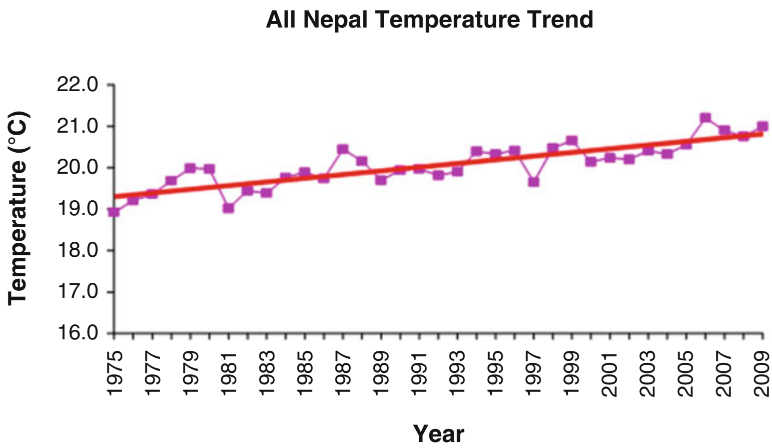

Fig. 14.4 All Nepal temperature trends (Kandel 2012)

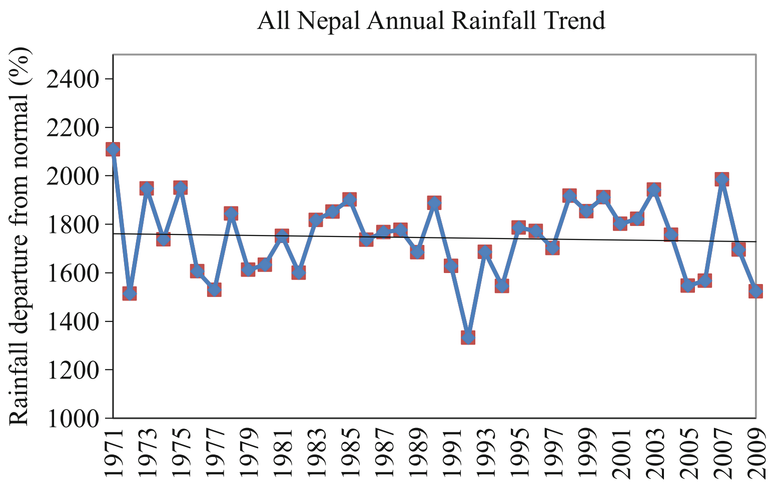

Fig. 14.5 All Nepal annual rainfall trends (Kandel 2012)

Figure 14.6 shows the land cover map of Nepal based on the Moderate-Resolution Imaging Spectroradiometer (MODIS) product MOD11Q1 in 2001 and 2012. The increment of the vegetation in the northern part of Nepal is clearly visible from east to west. This area is the mountainous region which is generally above 3000 m from mean sea level. Several researches (Dahal 2005; Mishra et al. 2014a; and others) have also reported the similar results in the higher altitude of Himalayas. In addition to that, the increment of vegetation in the higher altitude is the evidence of the receding of the snow cover area which is the widely accepted fact in this region and

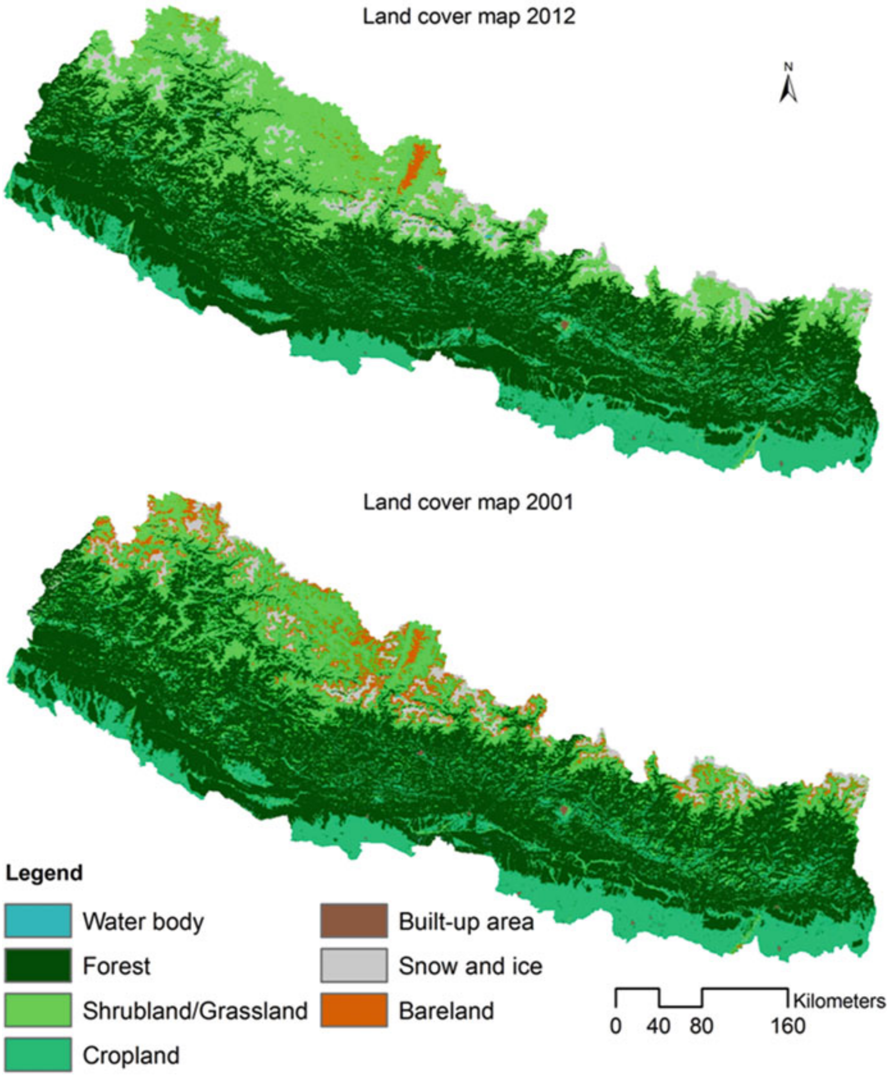

Fig. 14.6 Land cover map of Nepal, developed from MODIS Land product MOD12Q1

is one of the most visible effects of global warming. Even though this fact is not very visible in the map, cropland to built-up area in the plain Terai region is also increased considerably.

The mountain region is adversely affected by climate conditions such as excessive rainfall and relatively low temperature as well as natural disasters such as avalanches, earthquakes, etc. (Pal 2015). Furthermore, its poor and shallow soils are prone to erosion because of steep slopes. It is colder than the plain Terai region; therefore soil formation and vegetative growth rate are slow. It may be irreversible or reversible only over a long period of time, if once damage to mountain soil or vegetation (Jansky et al. 2002).

Finally, changing climate condition and increasing frequency of disasters and state of food insecurity are the motivating factors to migrate to the plains of the Terai region from the mountain region. It leads to illegal settlements in the public land such as the riverbank which is a flood-prone area, and the people living on that place are always vulnerable. There is no fixed mechanism to prevent these illegal settlements for the safety of persons residing in these dangerous areas.

14.4 Major Issues Related to Agriculture and Food Security

Nepal is an agrarian country, where more than half of the population is dependent on agriculture. But due to the weather-dependent agriculture, it is very sensitive to changing climate. Nepal's agricultural economy has already heavily suffered from climate change, i.e., extreme and irregular monsoon rain, prolonged winter drought, flashflood, etc. Several studies (Poudel and Shaw 2016; Mishra et al. 2014a) have shown that rainfall between November and April is declining which adversely affects the yield of winter crop. Wheat and barley are primarily affected with winter drought. The World Food Programme (WFP) reported that winter drought reduced the wheat and barley production by 14 % and 17 %, respectively (FAO 2010). The Ministry of Agriculture and Cooperatives (MOAC) predicted that the average maize production has declined by about 20 % due to the late monsoon and drought (MOAC, WFP and FAO 2009). Rice is the main source of food in Nepal, which is particularly sensitive to climatic conditions, mainly decline in the western mountainous region where a majority of the population is living below the poverty line.

This uncertainly threatens overall food security in the country. Thousands of people of this area are facing severe starvation almost every year. Summer crops often get excesses of water or are inundated, and most winter crops and those planted during the spring are suffering from drought. A report released in September 2009 by British aid agency Oxfam said that more than one million Nepalese suffered severe food shortages because of the drought in 2008/2009 (MoEnv 2012). Reports from several districts confirmed that the rice plantation date is also shifting due to the late monsoon. Further, vulnerability assessments of rice yield have shown that a 4 °C raise in temperature and 20 % increase in precipitation could result in a marginal increase in yield from 0.09 to 7.5 %. Beyond that, the yield would decline (Fig. 14.7, Koirala and Bhatta 2010).

It seems that changing weather patterns, rising temperature, winter drought, and erratic monsoon have started to affect food production. Farmers are not able to feed themselves and obliged to burden debt to fulfill their hunger. Climate change is one of the most accountable factors for food insecurity and livestock production that is identified by the local community (MoEnv 2010). On the other hand, loss of biodiversity, land degradation due to inappropriate use of fertilizer and pesticides, encroachment of forest land, and declining soil organic matter are key environmen-

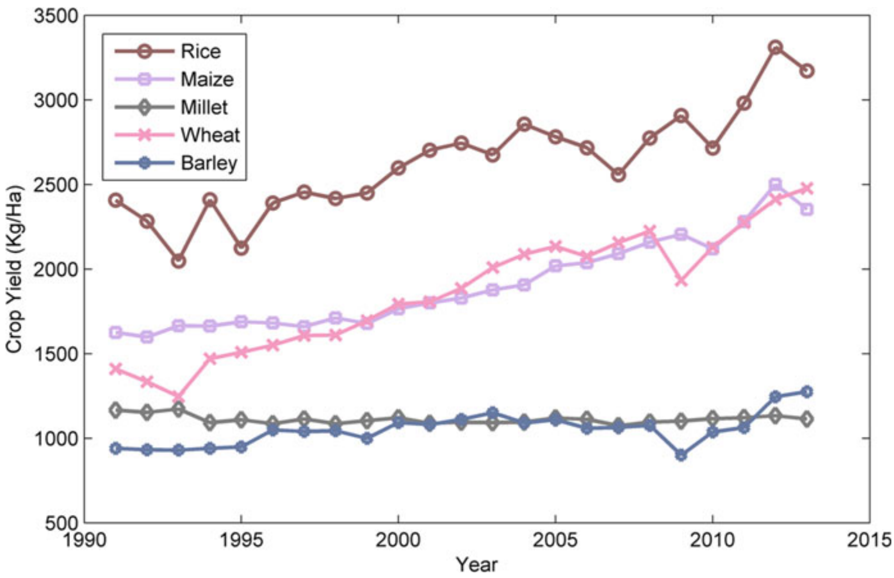

Fig. 14.7 Major agricultural crop yield in Nepal (MOAD 2014)

tal factors responsible for decreasing land sustainability and productivity. Similarly, infrastructure development, such as road and power plant using heavy equipment, has led to increasing landslide, flooding, and downstream sedimentation, leading to loss of productive soil resulting in inadequate food production (Subedi and Dhital 2007).

Besides the abovementioned issues, there are many socioeconomic and political problems related with the low agricultural productivity and food insecurity. In particular, the hill and mountain regions are vulnerable to food security and climate change due to their inaccessibility, fragility, and diversity (Subedi and Dhital 2007). In addition to that, political conflict has led to internal displacement causing food insecurity in some areas of Nepal. A decade-long civil war has increased displacements, internal migration, and overseas migration. More than 40 % of households in Nepal have at least one person migrated for overseas jobs leaving the elderly, disabled, women, and children in rural area of Nepal. These abandoned people are highly vulnerable during the time of disasters (Subedi and Bhim 2001).

14.4.1 Agricultural Land

In most parts of Nepal, the major land cover change includes the forest to agricultural land or agricultural land to built-up due to growing population and urbanization. The forest land encroachment is higher in Terai in comparison to hill or middle mountain. Similarly, due to the lack of effective land use plan, cultivable and productive lands are used for nonagricultural purposes such as housing, road construction, land grabbing, fallow land, land speculation, etc. Consequently, it leads to the irresolvable exploitation of natural resources, forest, and aquaculture. Similarly, changing climate pattern is posing a threat to agricultural production. Agricultural land development especially for farming is lacking. Similarly, squatters and illegal settlement are growing and reaching an extreme limit. The population of squatters are about 1.5 million in Nepal, and they are encroaching the public land. It subsequently reduces the open spaces available for agriculture fields (FAO 2010).

14.4.2 Forest

Forest plays a vital role in the formation of all economies all over the world. It provides not only timber and wood products but also offers a variety of valuable goods and services including implication for global climate regulations. As mentioned before, Nepal has variability in altitude and climate within a short span of width, and it harbors a critical forest ecosystem. Based on the ecological region, Nepal has three types of forest such as tropical forest, semitropical forest, and alpine forest. However, Nepal government has divided into two types of forest for management purpose, national forest and private forest. And the national forest is divided into the following categories:

- Government management forest
- Protected forest
- Community forest
- Leasehold forest

The Forest Act 1993 defines the forest as all the area which is fully or partially covered by trees. The Department of Forest Research and Survey (DFRS) has done a survey of the forest area by using the satellite images from 1994 to 1997 for the first time in Nepal. The report said that total forest area was 5.83 million hectares or 39.6 % of total land cover which was 42.7 % in 1978. Among the total forest area, 4.27 million hectares (29 %) were covered by trees and 1.56 million hectares (10.6 %) were shrublands (DFRS 1999). There have been no national forest inventories since 1994, so data on forest cover are solely based on 1994. According to the latest report of the World Bank, the forest area is 25.36 % in 2010 (RIMS 2014).

Nepal government has defined the national forest as all the forest areas except private forest. They may include protected forest, community forest, and leasehold forest. Protected forests are those which have been declared protected. Similarly, community forests have been operated and protected by the community forest user groups. Leasehold forests are those types of national forests which have been leased by a legally defined institution, forest-based industry, or community for the specific purpose.

On the special occasion of the Third National Conservation Day (September 23, 2010), Nepal government declared seven forests as protected forests considering their contribution to the biodiversity conservation.

- Khata corridor (Bardia, 5000 ha)
- Barandabhar forest (Chitwan, 10,400 ha)
- Mohana area and Laljhadi corridor (Kailali-Kanchanpur; area of both, 24,664 ha)
- Basanta corridor (Kailali; area, 40,782 ha)
- Panchase forest (Kaski, Parbat, and Syangja, 18,000 ha)
- Madani (Gulmi, 13,800 ha) (Yonzon et al. 2010)

Some literatures reported that 20 % of the total country's area is under the protected areas to conserve the biodiversity (Singh and Chapagain 2006).

14.5 Land-Related Laws, Regulations, and Policies

To address the increasing challenges of land use in Nepal, Nepal government has formulated National Land Use Policy in 2012. This policy is expected to introduce the scientific use of land so as to ensure the maximum utilization of land on an environmentally friendly manner. Nowadays, unplanned residential and urbanization areas are growing rapidly that consequently decrease the proportion of other land use. Similarly, encroachment of public lands by the squatters has grown, and occupying and leaving the land fallow has also increased. That results in decrease in the agricultural production and threats to the food security of the country. Therefore, the National Land Use Policy 2012 targets to solve these problems through newly defined rules and regulations.

According to the policy, land could be used for seven purposes: agriculture, residential, commercial, industrial, forest, public, and others when necessary. The policy aims to protect 40 % of the land for forest, encourages not to leave the barren land without cultivation, and inspires the maximum utilization of land for agricultural purposes (National Land Use Policy 2012, Nepal). Similarly, it encourages to control the fragmentation of land and proper protection of land with historical, cultural, tourist, and religious importance as well as manages development of housing by maintaining the balance between the environment and urbanization.

Nepal government has initiated different programs to promote access of disadvantaged communities in the land resources, for example, exemption of 25–40 percentage registration fee if the land is registered in the name of women, land to freed Kamaiya (semi-bonded laborers), active participation of community in community forest management, implementation of leasehold forestry to increase the access of poor and marginalized people in the land resources, and rehabilitation of freed Kamaiya and freed Haliya (semi-bonded labor), etc. (FAO 2010).

However, land use-related conflict prevails among different authorities due to the involvement of different institution in land use decision-making at the national level and local level as well. The land management authority is formulated with the coordination of different ministries such as forest, agriculture, urban development, etc. But there is no harmonious coordination among these ministries or mechanism to bring them together for developing “integrated land management policy.” According to Land Related Act 1964 (fifth Amendment), a united council is to be set up for developing the land use plan of the country; however, this council has no formal role, and it has not been able to come up with land use plans and implementation. One project is already started for the land use planning by the Ministry of Land Reform and Management, but it has no authority to fix the land use system in Nepal. Additionally, public works such as road expansion and irrigation are hindered by the unclear role among the ministries (FAO 2010). Similarly, at the local level, land-related conflicts exist between the local government, local community, and political parties. Due to the political instability in Nepal, landless squatter settlement is a big issue for the proper land management.

14.5.1 Agriculture-Related Policies

Nepal’s agricultural sector provides livelihood for more than 74 % of its population and contributes almost 35 % of GDP. However, only about 25 % of Nepal’s surface area is suitable for agriculture (CBS 2013a). Similarly, uneven distribution of suitable land is widespread across the ecological belts where nearly 90 % of land is divided between the hills and the Terai with the remaining 10 % of the cultivable land in the mountainous region. About 21 % of the land is cultivable of which 54 % has irrigation facilities and the rest of the agricultural land is depending on rainfall (MOAD 2012). Nearly 45 % of the farmers own less than 0.5 ha land which is only 13 % of the total land. Furthermore, agricultural land is changing into built-up area rapidly resulting to decrease in agricultural productivity.

Considering the chaotic use of agricultural land, Nepal government developed an Agricultural Perspective Plan (APP 1995–2015) with the aim of alleviating poverty and improvement of agricultural systems of Nepal. Unfortunately, it suffered from the lack of political commitment and financial supports from the planners and politicians. In addition to that in 2004, the Ministry of Agriculture and Cooperatives (MOAC) formulated the National Agricultural Policy (Rastriya Krishi Niti 2061) with the objective of increasing agricultural production and productivity, develop commercial and competitive agriculture, and conserve biodiversity and natural resources. Similarly, Nepal government has also formulated a National Irrigation Policy 2004 with the aim of providing irrigation facilities in all arable lands throughout the year (FAO 2010).

14.5.2 Forestry Policies and Regulations

To preserve the biodiversity and prevent the increasing rate of deforestation, the National Forestry Plan (NFP) was formulated in 1976 which was the first forest policy in the history of Nepal. This policy emphasized the proper and sustainable development of forest and related industries (HMG/ADB/FINNIDA 1988). Then, this policy was followed by the preparation of the Master Plan for the Forestry Sector (MPFS) for 1989–2010; it was a strategic framework for the forest sector policy development and planning. The main objectives of this policy were to preserve the ecosystems, increase the local and national economies, and support the livelihoods of marginalized people. Hence, the Ministry of Forests and Soil Conservation (MoFSC) took the initiative to prepare a new plan for the forest sector under the leadership of the Secretary of Forests. Besides these policies, Nepal government formulated the National Conservation Strategy (NCS) in 1988 as a national follow-up response to the World Conservation Strategy adopted in 1980. Similarly, there is a Revised Forest Sector Policy 2000 with the some long-term objectives, which are described as follows (Amatya and Shrestha 2002):

- To enhance food production through an effective interaction between forestry and farming practices
- To support poor people's livelihoods for their daily lives
- To protect the land degradation and other associated effects which impact ecological balance
- To Increase community participation in forest management

14.5.3 Environmental and Protected Areas Regulation and Policies

Protected areas are managed by the Government of Nepal when the government deems these areas important specially from environmental, biodiversity, scientific, cultural, etc. aspects. The main objectives of announcing the protected areas are to conserve, manage, and use flora, fauna, and landscape with the natural environment as well as prevent the disappearance of wildlife and their habitat. Environment Protection Act 1997 and Environment Protection Regulation 1998 are implemented in Nepal to conserve biodiversity and to promote sustainable development of natural resources. Moreover, it emphasizes to minimize the adverse effects in several thematic areas such as the environment, human health, animals, plants, and nature, to maintain a clean and healthy environment (Amatya and Shrestha 2002).

Nepal government has given authority to the Department of National Parks and Wildlife Conservation (DNPWC) to conserve, manage, and regulate the protected areas and biodiversity in Nepal. The protected areas include 12 buffer zone areas, ten national parks, six conservation areas, three wildlife reserves, and one hunting reserve. These protected areas cover the 23.23 % of the total area of Nepal (MoFSC 2015).

14.6 Future Land Management Strategies

Unsystematic and random use of land is widespread all over the world including Nepal. Land is degraded mainly for two reasons, one is due to climate-related hazards and the other one is encroachment of land in nonscientific way. Therefore, it is a huge challenge to make a proper use of land and maintain the quality of land. Similarly, unequal distribution of land is also another challenge in land management. In Nepal, the top 5 % owns more than 30 % of the land where the lower 47 % of household owns only 15 % of the total land with an average size of less than 0.5 ha (CSRC 2012).

Climate change is likely to worsen the situation not only in Nepal but also in many parts of the world where a high level of food insecurity is already prevailing (Poudel and Shaw 2015). In the case of Nepal, Terai region, which is the food bowl of Nepal, supplies the food all over the country. But a few years back, food production in this region has also decreased. The middle hills and the high mountains are very fragile, and a severe food crises occurs almost every year in those areas. Therefore, it is required to develop the proper land management strategies and land use systems for each region that ensures the sustainable land use and food security in Nepal and that may also help to prevent the deforestation to some extent. Hence, the following land management strategies could mitigate the increasing threats:

- Prioritize agroforestry system.
- Implement sustainable agriculture.
- Develop proper land use systems.
- Develop sufficient infrastructure.
- Multiply cropping systems.
- Enhance community forest programs.

There are some challenges to develop the integrated land use plan in Nepal. Comprehensive and reliable data on land use and land use change, climate variability, deforestation and its impacts on ecosystem, biodiversity, and livelihoods of the people are still lacking. This lack is being a major challenge for the policy planning, development, research, and action. The major problem is that Nepal government is not able to allocate adequate funds for the research and development of land-related issues at the national level. However, the land use project is established under the Ministry of Land Reform and Management, and it lacks human resources, material endowment, techniques, and supporting unit for developing land use plans that could enhance sustainable environment and agricultural production. Meanwhile, 45 districts out of 75 districts of Nepal are preparing the land use map with the help of already existing maps and other resources (FAO 2010).

Similarly, political instability is another challenge for the land use planning and disaster risk reduction in Nepal. Nothing is possible to implement without a strong political commitment. Therefore, formulation of a strong and powerful institution is needed to bring other agencies and stakeholders such as forestry, agriculture, and urban development together.

14.7 Conclusion

Nepal is one of the highly vulnerable countries in the context of climate change and food insecurity. Due to its mountainous topography, Nepal has experienced the adverse impact of climate change and climate-related disasters more than global average since the last decades. Climate change-induced disasters such as glacier lake outburst floods and avalanches in the Higher Himalayas, landslides and droughts in the middle mountain, and heat waves, droughts, cold waves, and floods in the plain Terai region. Additionally, it is found that land use and land cover pattern has also changed possibly due to the climate change. Specially, in the Higher Himalayas, vegetation growth is clearly visible because of increased global temperature over the last decade. Similarly, agricultural land is changing into bare land due to prolonged droughts. The deforestation rate is widespread all over the country as well. Consider the fact that Nepal government has formulated different land use policies (agriculture-related policies, environmental, and protected areas regulation and policies) and forestry policies for the proper management of land over the last few decades. But their implementation is not effective due to the lack of political commitment and financial supports. There is no integrated land use planning that could be inclusive of all natural resources. Proper recording of community and public land is still lacking, and there is no information about the extent of this type of land.

Decentralization of land use planning is required so that local bodies such as the District Development Committee would be able to develop land use plan for the district level consulting with all stakeholders. The government must initiate to reform clear, comprehensive land use policy to promote transparent, inclusive, and accountable land use governance. The poor and marginalized groups must have adequate opportunity to engage in climate change-related decision-making and sustainable farming to ensure their food security.

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Chapter 15
Post-Morakot Land Use Implications for Taiwan

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Abstract Because of its geographic position and special topography and geological conditions, many disasters have been caused by earthquakes and extreme rainfall in Taiwan in recent years. Especially, climate change brings about extreme rainfall intensity, and typhoons bring extreme torrential rain, which usually causes landslide, debris flow, and flooding in mountain areas and low-lying areas in Taiwan, such as the disaster Morakot that resulted in the greatest casualties to Taiwan in 2009. Based on the results of field surveys, the lack of an integrated plan of land use and extreme rainfall are the causes bringing about these catastrophic disasters. The Government has applicable policies in response on rule-making and policy implementation for avoiding similar problems happening again. For example, in the Typhoon Morakot Reconstruction Special Act, development is prohibited in specific areas and insecure areas to avoid repeated threats to living safety in environmentally sensitive areas and vulnerable areas. In addition, after Morakot many counties reviewed the articles of the regional planning law to enhance the measures of disaster adaptation and disaster mitigation, including the norm of land use on hillside land and governing in coastal flooding areas, intending to reduce casualties and property losses from disasters through applicable land use strategy.

Keywords Disaster Morakot • Land use management • Climate change

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15.1 Introduction

The disaster Morakot was a terrible flood from August 6 through August 10, 2009. The typhoon struck Taiwan for about 96 h, and the torrential rain caused much damage, especially in central and southern Taiwan. The people confronted the most catastrophic flood of the past 50 years. This section analyzes the extent of the damage and its influence on Taiwan.

15.1.1 Damage Extent

Typhoon Morakot made landfall in Hualien, in eastern Taiwan, and remained in Taiwan about 5 days. The greatest rainfall in Taiwan caused by Morakot occurred in Chiayi and Pingtung counties. Typhoon Morakot caused the most catastrophic damage of the past 50 years, including soil loss, driftwood deposits, floods, and flooding. According to statistics of the Typhoon Morakot Central Disaster Emergency Operation Center, Morakot caused 699 deaths and disappearances and 4 injuries; traffic was stopped, and power failures, water outages, agriculture damage, water conservancy facilities damage, serious soil calamities, channel-fill deposits, driftwood deposits, and flooding, etc. occurred (Jenn-Chuan Chern 2010).

When Morakot struck Taiwan, the Siazhu River, next to Siaolin village (Chiahsien township, Kaohsiung county), rose suddenly and sharply; in an undeveloped area named Mountain Xiandu, more than 1000 m in elevation at the northeast side of Siaolin village, a landslide occurred because of the torrential rain, which brought a large amount of sediment flow into the Nanzixian River, causing the river course to become blocked by sediments and form a large dammed lake. The 9th to 18th neighborhoods of Siaolin village, including the Siaolin elementary school, Siaolin Public Health Center, and Siaolin Police Station, were all destroyed by the floods and landslides, and 491 residents disappeared.

15.1.2 Environmental Impacts

The areas suffering the main influence of Morakot are in central and southern Taiwan. Heavily damaged areas are Nantou, Chiayi, Tainan, Kaohsiung, Pingtung, and Taitung (Fig. 15.1); among them the most seriously damaged townships are Chiahsien (Siaolin village), Namasia, Liouguei (Xinkai village) in Kaohsiung county, and Linbian, Jiadong in Pingtung county, and Beinan (Jhihben Hot Spring area), Taimali in Taitung County. The greatest rainfall was in Alishan of Chiayi county; the cumulative rainfall in 3 days of about 2854 mm caused serious flooding in central and southern Taiwan (Fig. 15.2). After Morakot, new added collapses totaled 39,492 ha, and the estimate of mud–sand production was 12,000,000 m^3

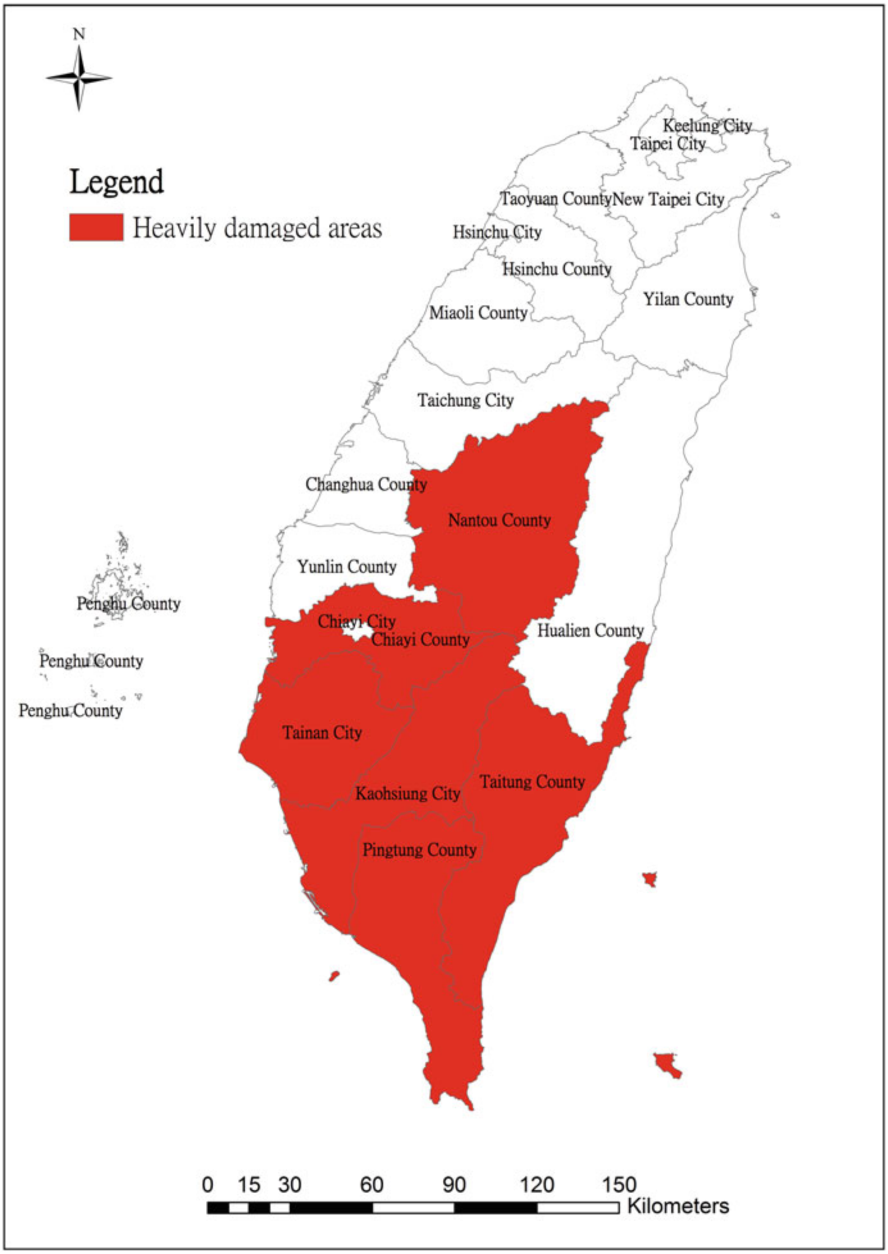

Fig. 15.1 Heavily damaged areas in Taiwan caused by Morakot

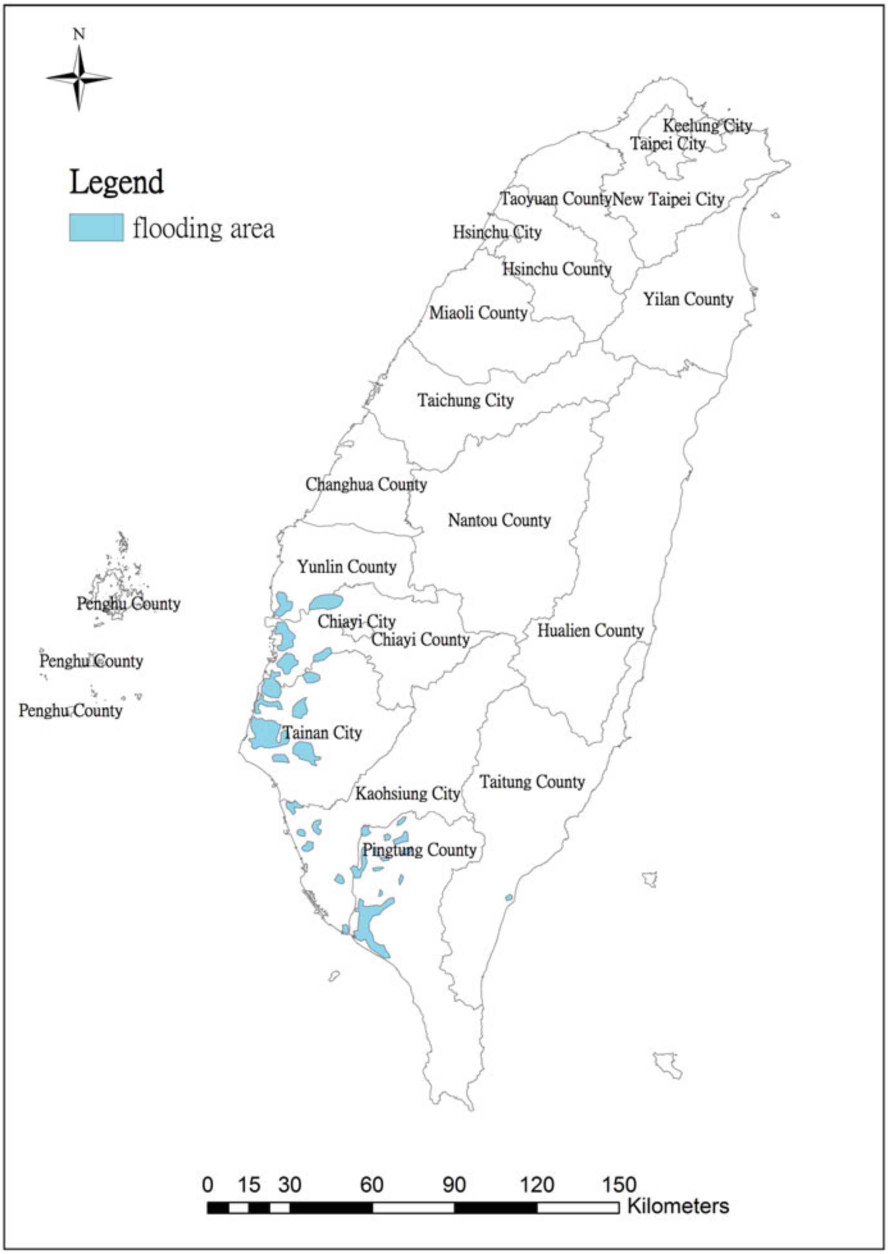

Fig. 15.2 Distribution map of the flooding area

(equivalent to 650 Taipei 101 buildings); among these the amount of residual slopes is 800,000,000 m^3 and the amount of effluent sand is 400,000,000 m^3 (Jenn-Chuan 2010). Seventy-five percent of the collapse was distributed among areas 200 to 2000 m in elevation, especially between 600 and 1600 m, involving about 50 % of the collapse. Grades between 20° and 50° were involved in 80 % of the collapse, especially that of 30°–40°, involving about 35 %. The distribution map of landslide disasters caused by Morakot is shown in Fig. 15.3, from which we can see the main area of landslide disaster is in Chiayi, Tainan, and the mountain areas in Kaohsiung, and these areas are also the locations of hillside development and villages (Landslide Disaster Reduction Team of National Science and Technology Center for Disaster Reduction, and Department of Social and Regional Development, National Taipei University of Education 2010).

15.1.3 Impacts on Victims of Morakot

Typhoon Morakot came in August 2009. In all regions, the high intensity and long duration of the rain caused catastrophic disasters in southern Taiwan and brought large-scale collapse to many places. These natural disasters cannot be controlled by humans, usually because of carelessness or lack of concern, and the consequences are unpredictable and inconceivable. Disaster Morakot inflicted serious damages in Kaohsiung, causing much damage to property, families, life, and the spirits of the victims. The most catastrophic damage occurred in Siaolin village, Chiahsien township, and Nansalu village, Namasia township. Nansalu village experienced a landslide disaster, in which were destroyed people's homes and the city center; many people were forced to move to other towns to restart their lives.

This section is about the impacts on victims of Morakot, involving environment and psychology.

15.1.3.1 Impacts on Rural Social Life After Morakot

Disaster Morakot brought large-scale flooding to rural homes, farm losses, traffic stoppages, and it threatened the safety of victims' lives and caused total agriculture loss at a record high of about 129 hundred million NTD. Among them, total crop loss was 49.9 hundred million NTD, the total loss of farmland covered up or blown away is 76.5 hundred million NTD, and the total accumulated losses of agriculture facilities are 2.5 hundred million NTD (Council of Agriculture, Executive Yuan 2010).

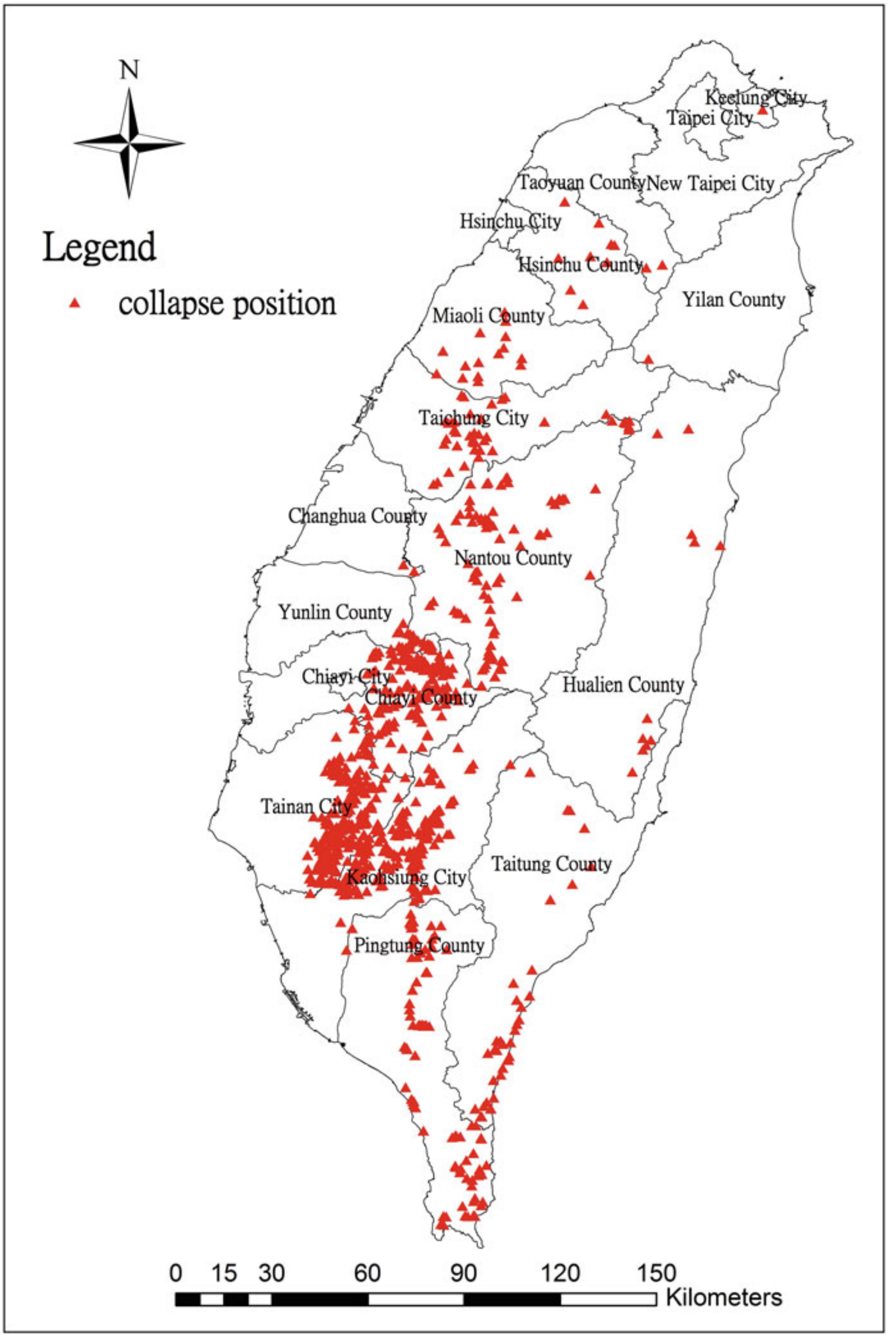

Fig. 15.3 Distribution map of landslide disasters that happened during the Morakot Typhoon

15.1.3.2 Impacts on Public Health After Morakot

The first issue of public health in damaged areas is the garbage left by Morakot, which made the environment dirty and odorous and will foul the water, causing victims to be threatened by communicable diseases. Moreover, if the water supply and power supply cannot be recovered at the first opportunity in damaged areas, some problems might be easily be caused such as keeping food fresh and sanitation. Waterlogging and a dirty environment are present in damaged areas, and when victims clean their homes after a disaster, they usually risk post-disaster communicable diseases and impaired health because of contacting dirty water and mud or because waterlogging results in the multiplication of the vector mosquito fly.

15.1.3.3 Impacts on the Spirits and Mentality of Victims of Morakot

Typhoon Morakot inflicted serious damage in southern Taiwan. When many first-line rescue medical personnel went into the damaged areas, they faced was dead people, destroyed buildings, and crying and shouting everywhere. When people are immersed in fatigue and helplessness for a long time, having uncomfortable mental reactions is difficult to avoid. The most gnawing thing to the victims is that the situation would not be getting better with the passage of time. Moreover, being in touch with the bad news from media reports might have negative influences on their bodies, emotions, and thoughts. Generally speaking, people might have experienced some different kinds of mental reactions after experiencing disasters. Most people will have some symptoms of post-traumatic stress disorder (PTSD), which usually manifests in 3 months, and in some the reaction is delayed to several months or several years later. After a disaster such as Morakot, especially when it threatens life or brings catastrophic damage, the post-disaster emotional and spiritual syndrome is usually one of the effects on victims still living. After the disaster, it is only a start for the recovery of the victims; to help them restore them from PTSD, the most important matter is to introduce and use the power of social support skillfully (NCDR 2010).

Even so, people are still working hard on reconstruction after the disaster; for example, in all townships in mountain areas including Liouguei, Taoyuan, Jiasian, and Namasia, floods and the flow of debris broke down many external access roads. Many villages and famous scenic areas (e.g., Bulao Hot Spring, Maolin National Scenic Area, Baolai Hot Spring, and Liouguei scenic area) were seriously damaged, but reconstructions were started one after another by the cooperation of central and local governments, and NGOs, after the disaster. For more than 1800 people, 756 Yuemei permanent houses were finished so they could start their new life here. The Kaohsiung City Government gave guidance to inhabitants to establish a "Shanlin-Daai Park Management Committee" to help them manage their community and do reconstruction work together. Also, the broken-down Jiasian Bridge was finished 4 months sooner, which improved external access in Jiasian, Namasia, and the connection to Baolai, Taoyuan, etc. The recovery of roads in Jiasian and the tourism industry are expected to revitalize the local economy to assist victims to return to a normal life as soon as possible (research report of the Control Yuan 2010).

In addition, Tai-21st Highway in Kaohsiung from Qishan, Shanlin-Daai village, Yongling organic agriculture farm, Jiasian business district, Wulipu-Siaolin village, an Siaolin village memorial park, etc., will form an embryonic form of gallery with national demonstration significance, including the Yongling organic agriculture farm, which is expected to develop into an organic agriculture distribution center, for supporting victims to obtain employment and continue well; the purpose is positioned with "Living, Producing, Ecology," three kinds of industries, combined with Art, Holiday Farm, and Organic Products sales, providing a diversity of experiences when traveling. This center is expected to create 500 jobs and rebuild artificial scenery provided with ethnic group culture and life educational meanings.

When a typhoon arrives, even though emergency rescue in the early stages is important, applicable reconstruction policies and enforcement plans are also important for the victims' future, not only to mobilize social resources from outside damaged areas but also significantly to encourage the victims themselves to improve their motivations and intentions. The final purpose in reconstruction of a typhoon catastrophe is that victims could recreate new chances and help people in distress, and this can attain the utilities of disaster prevention, disaster rescue, and life reconstruction.

15.2 Review of Causes of Disaster Morakot

Typhoon Morakot resulted in many types of disasters in southern Taiwan in 2009, including landslides and floods. The causes of the disaster are mostly related to the extreme rainfall and poor land use. This section is the analysis of factors related to this issue.

15.2.1 Inadequacy of Land Use

The types of landslide disaster caused by Morakot are collapse and debris flow, also disastrous floods in low-lying lands. The cause of collapse and debris flow in mountainous areas is probably poorly planned land use of hillside lands, and the cause of flooding is probably the long-existing land subsidence problem at shorelines and inadequate land governance along rivers.

According to research, Morakot caused large-sized collapse in several catchment areas of reservoirs: Zengwen reservoir in Dapu, Chiayi is an example, with a collapse area about 1467 ha, and Nanhua reservoir in Nanhua, Tainan, with a collapse area about 810 ha. Most collapse areas occurred upstream and midstream of catchment areas, probably the result of heavy rainfall. But there was only a small area of collapse, about 24 ha, in Mudan reservoir (Mudan, Pingtung), probably because of good vegetation, a better lithological character, and less artificial development in the catchment area of the reservoir (NCDR 2010); this difference suggests that artificial development in the catchment area has a partial effect on the collapse of hillside land.

To understand the relationship between landslide disaster and land use, we can see Namasia in Kaohsiung as another example, based on the survey results of nationwide land use from the National Land Surveying and Mapping Center (Disaster potential maps website of NCDR). The potential debris flow torrent area for a landslide disaster is 65 % in Namasia; if classifying land use in Namasia, we know the largest part of the potential debris flow torrent area is used for agriculture (47 ha), and the next is forest (34 ha). Because the moisture-holding capacity of crops is less, land in agriculture use might be seriously damaged as a debris flow occurs, and for this reason land use in damaged areas shall be adjusted from a landslide disaster region.

Excepting collapses on hillside land, flooding in the plains region is also related to exploitation and management of the lands or channel governance. Morakot caused estuarine expansion in Taimali River, Taitung, and levee failure and inundation in Linbian River, Pingtung, because the original river region was brought into regional development or the levee restricted the flood space. In addition, settlements downstream of Zengwen River had experienced previous flood disasters; although the Zengwen reservoir can provide flood relief upstream, the flood space downstream is too small so that floods can still exceed the levees and cause levee failure (NCDR 2010). So, illegal land use and misuse of land should be modified.

15.2.2 Excessive Rainfall

Morakot had high-intensity rainfall patterns and a high accumulation of rainfall for the long time of 96 h, and heavy rainfall from August 6 to 8 that exceeded the engineered standard of watershed flood control, and the steady accumulation of rainfall on hillside land in catchment areas caused serious disasters. A single episode of maximum rainfall in 24 h or in 48 h both rank in the top 20 events in historical records, so we can see the total accumulated rainfall of Morakot is greater than that of other typhoons with a wider distribution region. The 48-h accumulated rainfall of Morakot is greater than that of Typhoon Herb, becoming No. 1 in Taiwan's typhoon history.

Most disasters of Morakot were compound disasters, including collapse, debris flow, dammed lakes, driftwood, levee failure, traffic obstructions, flooding, and channel-fill deposits, which are related and dynamic, differing from an earthquake, which is short term and concentrated. This section sums up all types of disaster causes related to exaggerated rainfall intensity (NCDR 2010).

15.2.2.1 Flood Disasters

1. The hourly precipitation rainfall intensity in many regions overwhelmed the engineered standard of the rainwater drainage system, delaying drainage of deluges and causing flooding.
2. Extreme rainfall in mountain areas caused many hillside land collapses; a large amount of mud and stones was washed by the deluge to midstream and downstream, resulting in heavy deposits in rivers and reduced water areas that were then inundated.
3. Many levees were broken in this disaster because of flood discharge on rivers that exceeded the engineered protection standard, resulting in flood disasters; for example, the levee was broken and caused a flood that rose higher and higher, flooding over the whole village downstream of the Taimali River in Taitung. Linbian, Jiadong, and Donggang in Pingtung are in land subsidence and flood risk areas, and they also had serious floods caused by levee failure of the Linbian River.
4. Land subsidence areas in Dongshih, Budai in Chiayi, Dacheng in Changhua and Kouhu, and Sihhu in Yunlin also had flood disasters.
5. Water levels on several rivers exceeded Level 1 alert; the high water levels caused failure of the waters to drain away and the occurrence of ponding on both sides along rivers in low-lying areas.

15.2.2.2 Landslide Disaster

1. The main basins of collapse caused by Morakot are Gaoping River, Jhuoshuei River, Zengwen River, the Taitung coastal river system, and Linbian River; the collapse area in all basins after the disaster is as great as 39,492 ha. Only a small number of these basins are agricultural use land; the others are mainly on forested land. Further analyzing land use types in collapsed areas, forested land is the land type in which collapse most easily occurs. The largest collapsed area is also on forested land; forest land collapse midstream and upstream in basins is the major cause for large amounts of soil, stones, and driftwood midstream and downstream. We estimate a large amount of collapse on forested land occurs because of rainfall intensity that exceeds the hillside slope capacity.
2. The geology in southern Taiwan is mostly mudstone, sandstone, shale, and sandshale; very serious weathering occurs in these geologically vulnerable areas. A heavy rain will cause faster collapse and soil erosion, and then disasters can happen.
3. The roads in mountain areas were blocked or failed to drain because of heavy rain, which washed out the roadbeds and resulted in hillside slope collapse up and down from the roadbeds.

Also, the heavy rain also damaged public buildings or structures, such as the many roads that were seriously damaged mainly because the accumulated rainfall was too great and the duration of the rain too long, exceeding the tolerability of the slope of the roads. In another event, the main structure of a bridge could not resist the instantaneous force and was destroyed because the flood washed it away, or debris flow that occurred upstream and the height of the river's flood stage or its flow exceeded the design peak flow of the bridge. Further, because of the heavy rain the levees were attacked and washed out by flooding, causing levee failure.

15.3 Land Use Management After Morakot

According to the points previously mentioned, a part of the disaster caused by Morakot is land use and management. Thus, this section probes landslide disasters, discusses the relationship between land use and landslide disasters, and discusses how the Government should develop the norm of land use post Morakot.

15.3.1 Geological Disaster Potential in Taiwan

Before interpreting hillside land use in Taiwan, we should know the locations where geology disasters such as collapse or debris flow might occur. If we can categorize land use types in Taiwan and overlap these with sites of potential geological disasters, we can analyze the relationships between all kinds of geological disaster potential and land use. This section can only interpret from the disaster potential data we have collected. Several great typhoons, floods and earthquakes such as the Jiji earthquake occurred in Taiwan; the geological disaster potential is enhanced every year. Four types of geological disaster in Taiwan are slides of debris, rock slides, falling rocks, and dipping slopes (Fig. 15.4a). The Morakot typhoon brought overly abundant rainfall, resulting in complex disasters happening all at one time, such as hillside land collapse in mountain areas, debris flow, flooding, dammed lakes, and dam failure. The heavily damaged areas of landslide disaster are in Nantou, Chiayi, Tainan, Kaohsiung, and Pingtung (Fig. 15.4b). In the disaster site pictures shown in Fig. 15.5, debris flow and collapse in the Chiayi mountain area caused by Morakot are shown. Comparing with Fig. 15.4, we can see the collapse positions caused by Morakot are similar with the results of geological disaster potential predicted from research, which shows that we already can preliminarily control the signs and characteristics of geological disaster caused by natural disaster events, and this will help us to carry out preventive geological disaster work in the future.

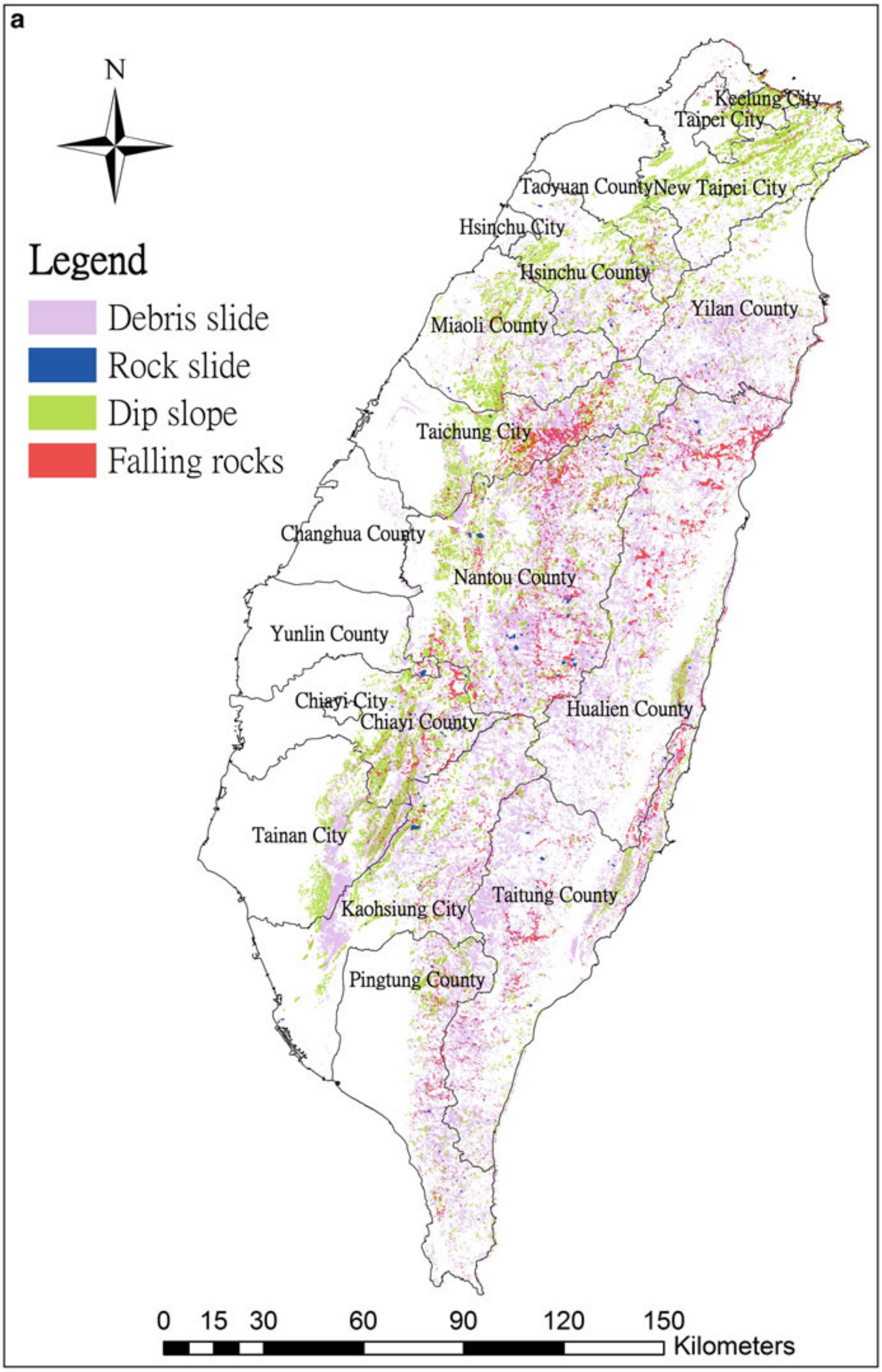

Fig. 15.4 Taiwan geological disaster potential and collapse positions caused by Morakot. (**a**) Taiwan geological disaster potential.

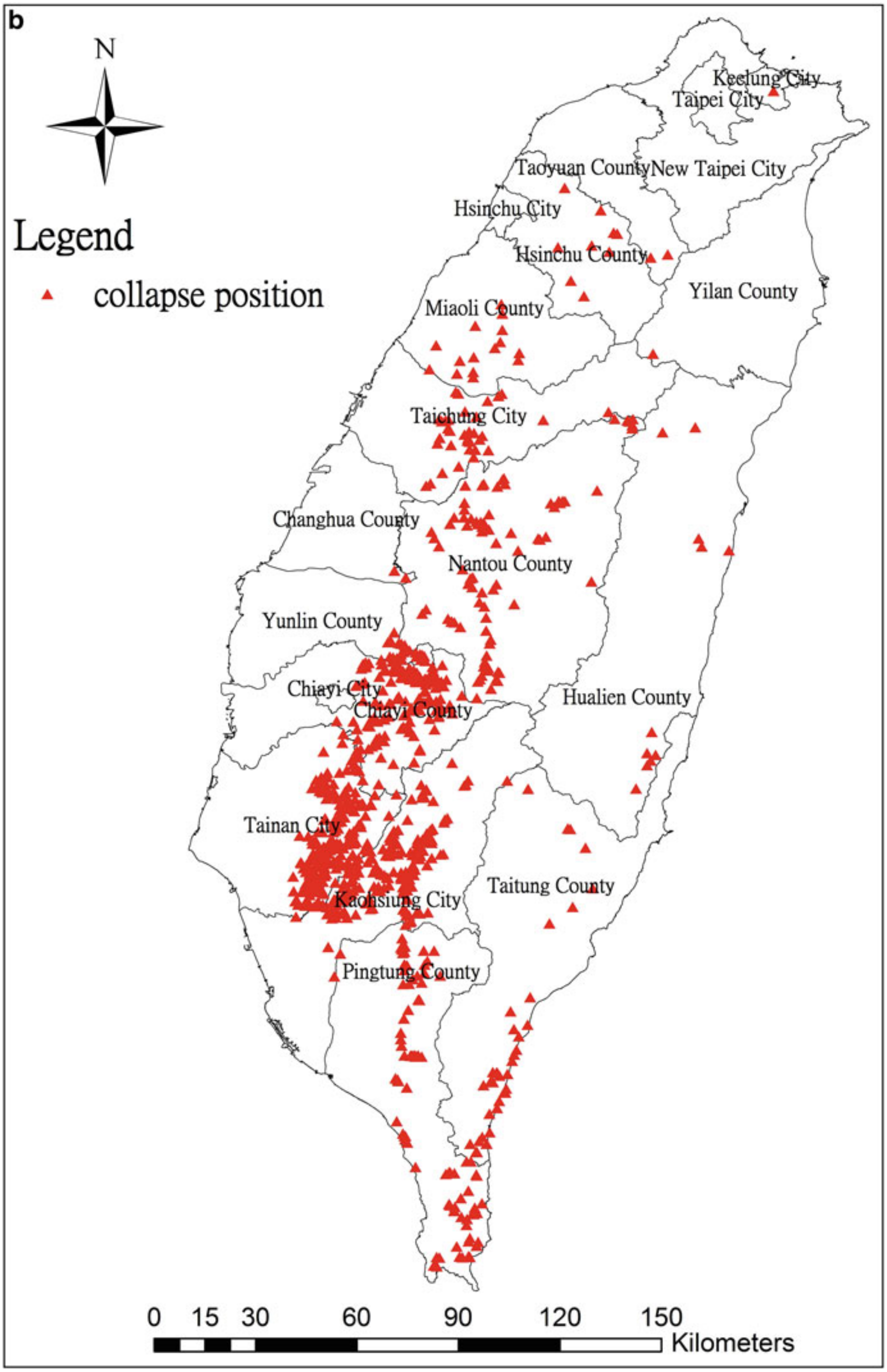

Fig. 15.4 (continued) (**b**) Distribution map of landslide disasters

15.3.2 Pre-disaster and Post-disaster Hillside Land Use

Before Morakot, hillside land use and management in Taiwan incorporated foundation placement, spreading, and hillside conservation and management, and establishing a Soil and Water Conservation Act, but there is no appropriate growth management concept. In the 1970s, Taiwan was just in the economic development period and the punitive provisions of the related legislation were too soft, so people developed hillsides for non-agricultural uses, such as buildings, recreational land use, and developing ore extraction, which caused the geological framework of a hillside to be broken. Also, increasing planted areas of high-value cash crops caused

Fig. 15.5 Disasters caused on hillside land in Taiwan by Morakot. (*Source:* Mu-Fan Tsai, SWAN)

Fig. 15.6 Inappropriate hillside land use in Taiwan (*Source:* Yi-Chun Liu, SWAN)

overuse of hillsides for such crops as tea, betel nut, and high mountain vegetables (Fig. 15.6). These actions have implications for soil and water conservation in Taiwan, because if high-intensity or long-duration rains exceed the slope capacity of a hillside, it will cause landslide disasters such as followed the heavy rain of Morakot, which resulted in catastrophic disasters on hillsides in Taiwan (Research, Development and Evaluation Commission, Executive Yuan 2009).

After Morakot in 2009, to provide an excellent arrangement to the original residents, coherent units of the government and county (city) governments composed a task force giving consideration to several types of environmental disasters, if being considered as unsafe or illegal building through investigation; they consulted with the original residents and obtained a consensus, and thus delimited a special region in the Morakot-damaged area. Principles of special regional delimitation include prohibiting development in areas according to the law, the high potential of debris flow stream-influenced areas, overuse of land, serious land subsidence, degeneration of a river environment, or the probability of endangering the safety of a river. The special regional and unsafe areas were delimited mostly in Kaohsiung, Chiayi, Pingtung, and Yunlin. For comparing land use changes in these areas pre- and post Morakot, relevant studies analyzed the survey results in 2006 and 2011 from the National Land Surveying and Mapping Center: land use in special regional and unsafe areas mostly is in agriculture (41 %), second is forests (30 %), and then buildings (13 %) in 2006. The survey showed that the original land use for public and building uses still remains as it was, but land uses for water, forests, agriculture, and traffic purposes have been mostly changed to a collapsed position as seen from the aerial photograph in 2011 (Construction and Planning Administration 2012).

15.3.3 Research Regulations

According to the relevant acts and regulations, laws and regulations related to land use in Taiwan include the National Land Use Planning Act (Draft), National Land Restoration Regulation (Draft), Regional Plan Act, and Typhoon Morakot Reconstruction Special Act. This section interprets the content of these laws and regulations.

15.3.3.1 National Land Use Planning Act (Draft)

Climate change has brought about many disasters in recent years, and national land use planning is urgent and necessary; therefore, the Construction and Planning Agency, Ministry of the Interior submitted the National Land Use Planning Act into Legislative Yuan for examination from 1997. National land planning is based on sustainable development; the Act proposed comprehensive planning of Taiwan's national land use and expressly stated land use control. One proposal of this Act is based on land resources properties, environmental carrying capacity, and local development requirements to draw up land use control, ensuring sustainable land development. This Act is planned in accordance with natural resources, wildlife, and nature or landscapes, disaster distribution and its control facilities, and separated by environmental sensitivity classification. Most environmentally sensitive areas having rich natural resources, important ecology, rare landscapes, or vulnerable conditions are defined as national land conservation areas, and others are zoned by function. If conforming to the principles of a national conservation area, it shall be governed in accordance with use doctrine, and rely on resources, ecology, landscape, or disaster properties and degrees of banned or restricted use.

15.3.3.2 National Land Restoration Regulation (Draft)

Executive Yuan submitted the draft of the National Land Restoration Regulation, to review national land restoration and management and draw up its overall policy. This regulation implements control in regions including hillsides, river areas, coastal areas, offshore islands, and serious land subsidence areas (Construction and Planning Agency, Ministry of the Interior 2012). With the expectation of special permission, this regulation provides only aboriginal villages can perform self-sufficient agriculture in high-altitude mountainous areas; in other villages agriculture use and harvesting of forest trees is banned and existing crops shall abandon cultivation within a specified period. New agricultural and other new developments are banned in medium-altitude areas; land use planning and permitted use items shall be reviewed within a specified period on the basis of sustainable development in low-altitude mountain areas. Where delimited as a national conservation area, central and local governments shall draw up the restoration plan to reinstate the ecology system in overexploited areas and reduce development in environmentally sensitive areas.

15.3.3.3 Regional Plan Act and Regulations on Non-urban Land Use Control

The main propose of regional planning of direct-controlled municipalities and counties (cities) is doing a substantial land plan; this plan is at the highest position of statutory planning in the spatial plan system before the National Land Use Planning Act passed. As the National Land Use Planning Act has passed with announcement by direct-controlled municipalities and counties (cities), the Regional Plan Act has ceased functioning.

One main point in the regional plan is to adjust land use strategies to adapt to global climate change, to be an outline of land use strategies to adapt to natural disasters in the future for every region. The government of direct-controlled municipalities and counties (cities) shall transact disaster-related matters in related tasks for reviewing the urban planning district in high mountain areas, to decrease the intensity of land use development. Post Morakot all regional plans in northern, central, southern, and eastern Taiwan were reviewed. As an example, Kaohsiung city, because of loose strata in the debris flow disaster area in mountain areas, with a typhoon or a heavy rain coming landslide disasters easily occurred. The slow repair of roads and bridges influenced external access roads and disaster rescue roads. Some rivers had serious deposits and the levee was repaired slowly, so that a large amount of sediment was deposited or was not dredged in midstream and upstream, and when rain came again the levee might be washed away, causing unsafe living and property conditions for riverside residents. Regarding these problems, the regional plan offers related strategies and policy adjustments as follows.

1. Establish a standard norm of environmentally sensitive areas, controlling land use development, and review the related land use plan, delimiting suitable districts or public facilities to restrict land use.
2. Environmentally sensitive areas of ecological and disaster potential shall be restricted as to development. For example, potential flooding areas, such as Gaoping River and Linbian River, and serious land subsidence areas shall be restricted as to development intensity and density.
3. Building disaster prevention communities to enhance disaster prevention and salvage.

4. Speeding dredging and considering the possibility of a non-dredge reclamation with regard to Gaoping River deposits.

Regulations on non-urban land use control are made on the basis of the Regional Plan Act for protecting the living safety of the residents. The content of the regulations states that if a hillside use is changed, then the land of an established business plan is determined through architecture-related legislations: if there are steep slopes, bed geological structures, broken strata, active faults, or the sliding possibility of a dip slope, or there is a mine, a mound, a tunnel, an apprehension of danger around stream bank erosion or retrogressive erosion, and an apprehension of danger in the base of operations, and if there is an apprehension of danger on collapse or flooding, the land cannot be developed under the law.

15.3.3.4 Typhoon Morakot Reconstruction Special Act

To speeding reconstruction after Morakot, the Government enacted a draft of the "Typhoon Morakot Reconstruction Special Act" to adapt to each matter on September 28, 2009. The main point related to land use of this special act is that the central, directly controlled municipalities and counties (cities) governments must consult with the original residents and obtain a consensus, delimiting a special region, to restrict residence or coercively relocate homes or village within a specified period, and providing an acceptable arrangement; if within the land in disaster areas there is an apprehension of safety or illegal buildings, this is not restricted by other related norms. The land just mentioned might have problems of environmental sensitivity, debris flow disaster potential, hillside environment, flooding potential, etc. Further, to avoid a repeat of inapplicable residence land use, residents of the special region delimited by this act must coercively relocate the home or village within a specified period. Their own land and improvements on the land could be levied; if it is leased public land, the contract could be terminated and compensation obtained by the contract and related legislation. If there is no lease relationship, but the people are actually living or farming on public land, they could receive a relief payment counting land improvements. (This regulation was terminated and expired in 2014.)

Except legislation, there are related projects beginning to research the environmental sensitivity of the land, such as the Central Geological Survey, MOEA. These projects are the synthesis and induction of historic collapses, landslide areas, and dip slopes, zoning to landslide-landslip geologically sensitive area, warning that for development in these areas in the future, a geological survey and geological security evaluation are required before applying for land development, to observe the possibility of collapse and landslide disaster and to estimate the effects on the basis of land development activities caused by collapse or landslide, or the effects on slope stability from development activities. Having an applicable preventive and mitigating measures plan to reduce disaster risk, the Geology Act provides that the regulatory authorities for all relevant sectors shall incorporate data pertaining to geologically sensitive areas for reference in land utilization plans, land development reviews, hazard prevention and mitigation, environmental protection, and resource development. All types of land development activities that fall in a geologically sensitive area shall undergo a geological site investigation and geological security assessment according to "Criteria for a geologically sensitive area undergo a geological site investigation and geological security assessment," and carry out the geological survey system, geological permit system, and geological review system (MOEA 2014).

15.4 Applicable Land Use Management

All human activities are related to land, because all that is needed in our lives is obtained directly or indirectly from the land. Consideration of land use shall include social, economic, or technical purposes, except considering human activities; the situation of natural conditions is also a key point to estimate, such as spatial distribution, topography, and climate.

Under the interaction of several factors, different utilization plans might be required because of time and changes in the natural environment, even in the same land region (Kuang-Yi 2010). Land use refers to human activities that are directly related to the land. The four factors that influence land use are socioeconomics, nature, policy, and location (Tsou and Chang 2004), meaning that land use relates to economic development, suitability of environmental development, policy and system orientation, geographic location, etc. The legislation system of land use in Taiwan shall be considered and based on the foregoing four factors.

In terms of legislation, related legislation of land management in Taiwan shall be improved.

1. A detailed plan classification shall be enhanced, including population allocation, industry allocation, the traffic and communication network, water resources management, disaster prevention, important goods, and protection of sites (Lin 2012).
2. All types of regional environment delimited by the draft of National Land Use Planning Act shall provide a disaster mitigation purpose, draw up a grade of disaster risk regions, and rely on it to provide disaster prevention regulations (Chen et al. 2010).
3. Legislate the National Land Use Planning Act as soon as possible.
4. The substance of regional planning shall be enhanced, informing the public of danger areas, education, epidemiology, and disaster prevention drill, and maintenance management measures of meteorology, river stages, bridge security; debris flow monitoring and a warning system shall be implemented to reduce the extent of damage.

Disaster mitigation is the first step in disaster management tasks. Therefore, an integrated and rational management of land use is the key point to reduce the occurrence of disasters. Areas environmentally sensitive to a high degree shall be delimited to priority national land restoration areas, giving impetus to national land conservation and restoration, these areas being banned for development and use. The security of existing villages or tribes shall be reviewed, and villages may be relocated to reduce casualties and property losses and to decrease the large social costs of rescue and reconstruction. Further, in terms of disaster mitigation in the face of rapid changes in the environment, we shall use remote sensing technology on all types of land use, to enhance monitoring to control waste from all new developments in the land environment around basins, in environmentally sensitive areas, and in low-lying areas, and shall enhance reporting and crackdown on illegal land use. The next step in terms of disaster mitigation is to advise on several tasks of land use and management.

1. Overall governance of river basins

   Impetus must be given to comprehensive river basin governance tasks of water resources, water conservation and forestry, overall planning upstream, midstream, and downstream, and incorporating factors of disaster mitigation while governing and planning, such as estimating vulnerability, decreasing development density in low-lying areas and river reservations, and increasing permeable areas.
2. Reviewing the disaster resilience of existing villages

   Land use patterns combined with the industry of environmental ecology and the characteristics of our culture, and accepting increased security, also can ensure the sustenance of residents by guiding them to participate with public discussion, assuming responsibility and the results of improving their environment together. An applicable compensating mechanism can be provided to encourage private lands to have functions of flood detention and conservation. The Government shall develop residence restrictions or a coercive plan of village relocation for existing villages or houses where there are the greatest disaster threats.
3. Development activities banned in environmentally sensitive areas

   Environmentally sensitive areas in the jurisdiction shall be investigated and made public as soon as possible to increase restricted or banned development. Carrying out priority restoration in areas where serious disasters have occurred previously to enhance the control of all development activities, and reporting and cracking down on violating is certainly required; the Government shall enhance patrolling and controlling from the perspective of disaster mitigation.
4. Land protection and ecological environment restoration tasks

   The Government can improve and intensify the ecological protection of land in vulnerable areas through environmental conservation or restoration measures. Recovering land to its original state as much as possible, especially national land and arable and grazing land that is used or built on illegally, shall be a top priority for restoration and conservation. This approach will reduce pollution and soil erosion in catchment areas and conserve the storage capacity of reservoirs to increase a steady water supply.

5. Use and management of water resources

   Control of land development activities and over-abstraction of groundwater shall be increased in catchment areas, and advanced development and the raising of crops and livestock shall be banned in catchment areas to decrease ruining the environment, which is a threat to reservoir security. In serious land subsidence areas, establishing a new well shall be banned, and new water resources shall be developed instead to stop worsening environmental deterioration.

6. Enterprise transformation promotion

   There are tea gardens, betel nut gardens, fruit farms, and other related arable and grazing uses everywhere on hillsides today, and there are a large number of public and private wells in land subsidence areas. The Government shall provide guidance on enterprise transformation to ecotourism and the low water use industry to reduce environmental loss.

15.5 Conclusions

When a typhoon and heavy rain comes, or an earthquake occurs, it always causes serious disasters in Taiwan because of its geographic position and topography. Ensuring the safety of the lives and property of the people, with effective and applicable national land use, is the most important task for the Government. Facing the challenges of climate change, all compartments of the Government and People must face the increase of extreme weather events and review land use policies for effective management; furthermore, they shall undergo overall self-criticism of the benefits and security created from economic development.

The fundamental policies of hillside land use and management after Morakot in Taiwan are zoning environmentally sensitive areas and building up a control system of resources and land use performance, to implement national land use control, to protect fine arable land in balance with overall economic development, to enhance water resources conservation and manage the types and scale of land use in water source areas, to improve the permission system of land use changes by a fair mechanism, to implement growing management measures, to enhance coordination and integration of land use and government plans to implement sustainable development on off-shore islands, and to assign priorities of city and urban and rural development, etc. For adapting to high-intensity natural disaster events in the future, we shall investigate and plan ahead applicable short-term, mid-term, and long-term strategies to avoid large losses of life and property. Several proposals about land use and management are summarized following (National Science and Technology Center for Disaster Reduction 2010).

1. The short-term proposal
   - Check thoroughly the positions of communities and villages on hillsides in national lands and proceed with a security check, comparing their positions with historical collapse, and estimate possible disaster types and affected areas.
2. Mid-term proposals
   - Set different levels and purposes for protection or conservation areas in every basin, and investigate and plan ahead for different regulations of land use.
   - Fill low-lying areas and flood potential areas with sediment by grading, or move the sediments to costal land subsidence areas.
   - Widen channels or define floodway districts to give way to river reservation and keep the channels active.
3. Long-term proposals
   - To ensure carrying out the national land conservation plan, zone potential high-disaster areas and geological structures belonging to vulnerability areas, restrict development activities that might damage the structure of the hillside, and decrease the density of hillside land use.
   - Consider other traffic management measures such as cable cars or small to mid-size shuttle buses to reduce road development in mountain areas.
   - Review the afforestation strategy of forest lands upstream from reservoirs to enhance soil and water conservation in catchment areas.
   - Decrease runoff caused by hillside development, and hold the runoff water in flood detention pools if necessary.
   - Choose low-risk areas such as parks, a car park, school playgrounds, or swimming pools in which to save excessive floodwater to decrease the load on the rivers.
   - Enhance governance in land subsidence areas.
   - Restrict cutting and development activities in environmentally sensitive areas, such as ecologically protected areas, potential debris flow streams, and a protective forest belt of 50 m along both sides of rivers.

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Part IV
Coastal Issues in Land Use

Chapter 16
The Indian Ocean Tsunami and Land Use Changes in Indonesia

Syamsidik and Fachrul Fikri

Abstract Several tsunamis generated in the Indian Ocean have delivered impacts on land use and spatial planning for the affected areas. New regulations for city planning have also been introduced as part of mitigation efforts and to control land use in Indonesia. This chapter is aimed at elaborating the land use changes at several selected areas in Indonesia, those were motivated by tsunamis in the Indian Ocean. Three tsunami-affected areas will be taken into consideration in this chapter, namely, Banda Aceh and Meulaboh (after the 2004 Indian Ocean tsunami) and the Mentawai Islands (after the 2010 Mentawai tsunami). Policy change analysis was done, and it is coupled with spatial analysis using previous published data and images. Banda Aceh and Meulaboh were the most affected cities due to the Indian Ocean tsunami in 2004. Meanwhile, land use changes at Mentawai Islands are analyzed based on the latest interventions made around their areas. Three major units of land use were classified in this chapter. Relocation programs made at the three selected locations faced difficulties due to the land price hikes, and there are some coastal communities who work as fishermen, and this made them difficult to be relocated far away from coastal area. To prevent further uncontrollable land use changes at coastal area, the local Government of Banda Aceh and Meulaboh puts a strict regulation for the coastal area. Meanwhile, the disaster mitigation-based spatial planning in the Mentawai Islands is still in the process of formulation.

Keywords Land use • GIS • Houses • Spatial analysis

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16.1 Introduction

With more than 99,000 km of coastal line and with 13,466 islands, Indonesia has been acknowledged to be a country which has the second longest coastal line in the world (NATGEO 2013; CIA 2013). Simultaneously, most of the cities in Indonesia are located around a coastal zone. As Indonesia is also a place where four major earth plates collide each other, it puts Indonesia as among the most tsunami-prone country in the world. One of the most important tsunamis in this century is the Indian Ocean tsunami that occurred on December 26, 2004 caused by a series of earthquakes with the maximum magnitude that reached 9.15 Mw. The tsunami severely damaged coastal cities around Aceh province and Nias Island of North Sumatra province of Indonesia. Among the most severely damaged coastal cities were Banda Aceh and Meulaboh. More than two-thirds of the human casualties due to the tsunami in Indonesia were recorded from these cities. A recovery process for the affected areas was performed in 4 years, started from April 2005 until April 2009. The Indian Ocean tsunami is not only a giant disaster to Indonesia, but also an inspiration to disaster management reform in Indonesia. One of the reformations can be identified from a number of newly enacted regulations related to disaster management and spatial planning.

The rehabilitation and reconstruction process after the 2004 Indian Ocean tsunami in Aceh and Nias performed between April 2005 and April 2009 has brought significant changes on the region in terms of several aspects. Among them are land use, coastal population number, and public infrastructure aspects. Throughout the period of the process, about 140,304 units of houses were constructed to facilitate the tsunami victims, and 69,979 Ha of agricultural land were rehabilitated to help the farmers (see Fig. 16.1). Large amount financial supports were allocated by the Government of Indonesia and by other financial sources, including international agencies and foreign countries. When deciding for the resettlement area, the Aceh-Nias Tsunami Rehabilitation and Reconstruction Process Agency (BRR) came up with a contrasting settlement plan to desert about 500 m from coastal line from any housing complexes and large public infrastructures. This was inspired by the idea to construct a greenbelt area to the region as part of tsunami mitigation measures. This was stipulated in the Rehabilitation and Reconstruction Master Plan as an annex of Indonesia Presidential Decree No. 30/2005 (BAPPENAS 2005; Matsumaru et al. 2012).

Prior to the Indian Ocean tsunami, the number of coastal population who stayed just around coastal lines was large. One of them could be found around Ulee Lheue area of Banda Aceh and villages around Meulaboh City. Recently, although the number of the population was decreased after the tsunami, the remaining areas farther from the coastal line can be found relatively unchanged. Similar conditions were seen in the case of other Indian Ocean tsunami-affected countries, such as in India (Sridhar 2006) and Thailand. A study at Ban Nam Khem village of Thailand showed that most of the coastal communities did not want to be relocated to inland area because more than 80 % of the people were fishermen (Paphasit et al. 2006).

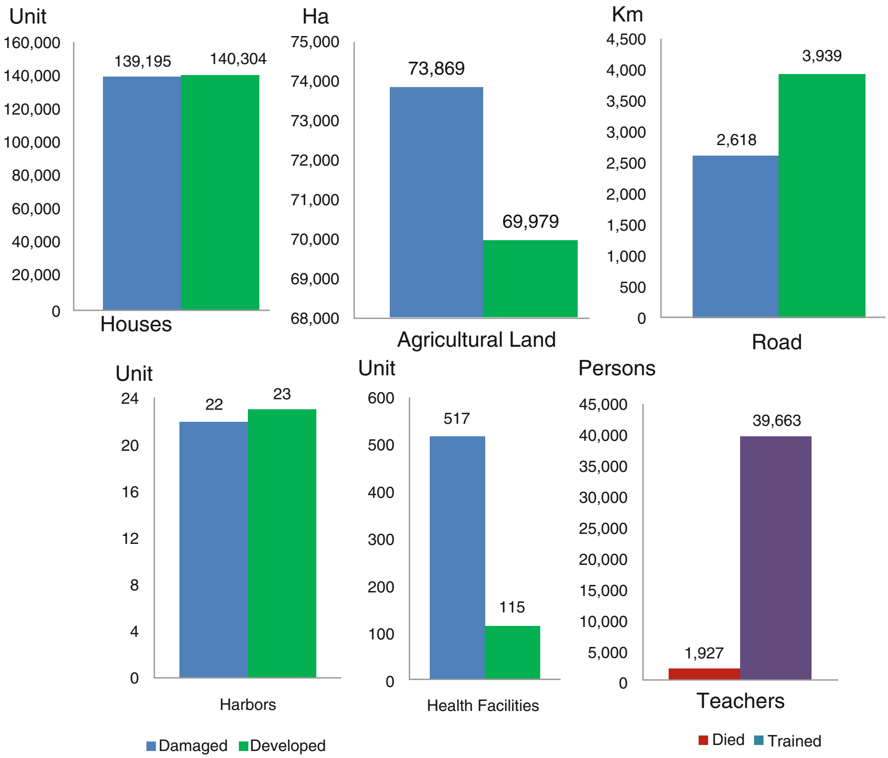

Fig. 16.1 Comparisons between the number of damaged units or dead teachers and reconstructed units or trained teachers during 4 years of recovery process led by BRR (Modified from BRR 2009)

The land use changes after the tsunami in southern Thailand often met challenges not only from local communities but also from private sectors (Attavanich et al. 2014). The failure of the initial greenbelt plan proposed by BRR was due to several problems. Among them is the sudden increase of land price for settlement that could not be afforded by the Government of Aceh. Another reason appeared to come from the settlers themselves who did not want to be relocated far from their original places due to social and economic reasons.

After 10 years of the recovery process, now Aceh has a new look in terms of land use. Although, the massive coastal populations are not found as similar to the condition before 2004, significant housing complexes still can be found at several places. During this period too, a number of population migrated into Banda Aceh and Meulaboh. The demography changes also reflect a number of new settlers in the cities. Until recently, there was no clear study to show whether the 2004 tsunami still remains a strong reason for the city settlers to select their place to stay. Furthermore, whether the tsunami drives the city population to inherit their houses

Fig. 16.2 Selected areas (in *black rectangulars*) in Indonesia for land use change analysis after the 2004 Indian Ocean tsunami (Modified from http://commons.wikimedia.org/wiki/File:Map_sumatra_natuna.png)

to their children or not was part of the big questions related to the demography changes and coastal population dynamic.

This chapter was aimed at capturing the land use changes at three tsunami worst affected areas, i.e., Banda Aceh, Meulaboh, and the Mentawai Islands. The locations of the land use changes elaborated in this chapter can be seen in Fig. 16.2.

16.2 Regulations on Spatial Planning

After the Indian Ocean tsunami, there are three important national regulations motivated by the giant disaster, i.e., National Law No. 24 Year 2007 on National Disaster Management, Law No. 26 Year 2007 on Spatial Planning, and National Law No. 27 Year 2007 on Coastal and Small Islands Management. The three laws specifically address the importance to shift the paradigm in the related topics after the severe impacts of the 2004 Indian Ocean tsunami. Previously, the spatial planning was regulated under National Law No. 24 Year 1992. The spatial planning consists of spatial utilization and land use controlling that includes disaster prevention and mitigation.

The Law No. 26 Year 2007 states several important points that were not identified in the previous law related to the spatial planning. At the considerations part, it is clearly mentioned that Indonesia is located in a prone disaster area; therefore a disaster mitigation-based spatial planning is needed to ensure the safety and to increase the quality of life of its citizen. Unlike in the previous law (National Law No. 24 Year 1992), we could not find a single word referred to the disaster in the main part of the law. The only part we could identify the disaster as part of the consideration is at the explanatory part of the law. For a large-scale disaster-prone area, the new law states that the spatial planning for the area is subjected to be reviewed at least once in 5 years. The disaster mitigation-based spatial planning is aimed at integrating the concept of the disaster mitigation into the spatial planning by incorporating zoning, land use controlling, safe points, shelter area, and evacuation routes.

In a lower law product, namely, Ministry of Interior's Decree No. 1 Year 2008 on City Planning Guideline, it is stated that a new city should not be developed if the city is classified as natural disaster-prone area. Besides regulating the land use, the spatial planning is used as a reference for other development planning documents, such as short- and middle-term development plans, investment guideline, and intra-region authorities' coordination.

In Law No. 27 Year 2007, the Government of Indonesia realized that the coastal area should be managed in order to be part of tsunami mitigation. The coastal area is mentioned in this law as an area within 100 m from the highest water level during flood tide. Later in 2014, this law was revised under Law No. 1 Year 2014 about the revision on the Law No. 27 Year 2007. However, there is no substantial change on land use for coastal area related to the disaster mitigation.

16.3 Land Use Changes in Banda Aceh

Banda Aceh is the largest city that was affected by the 2004 Indian Ocean tsunami in Indonesia. The number of the human casualties recorded from this city was also large. It is estimated around 92,000 people died around Banda Aceh and Aceh Besar district due to the Indian Ocean tsunami (BRR and UNORC 2005). Tsunami mortality percentage from this city prior to the tsunami was about 22.0 % (Rofi et al. 2006; Doocy et al. 2007a, b; Brennan and Rimba 2005). Banda Aceh is divided into nine subdistricts (*Kecamatan* in Bahasa Indonesia language). According to Indonesia National Land Agency (BPN), two subdistricts are classified as the most destroyed subdistricts (red zone), namely, Kecamatan Meuraxa and Kecamatan Kuta Raja (see Fig. 16.3). Six subdistricts are classified as destroyed subdistricts (yellow zone), namely, Kecamatan Syiah Kuala, Kecamatan Kuta Alam, Kecamatan Baiturrahman, and Kecamatan Jaya Baru. The other three subdistricts, namely, Kecamatan Ulee Kareng, Kecamatan Lueng Bata, and Kecamatan Banda Raya, had minimum

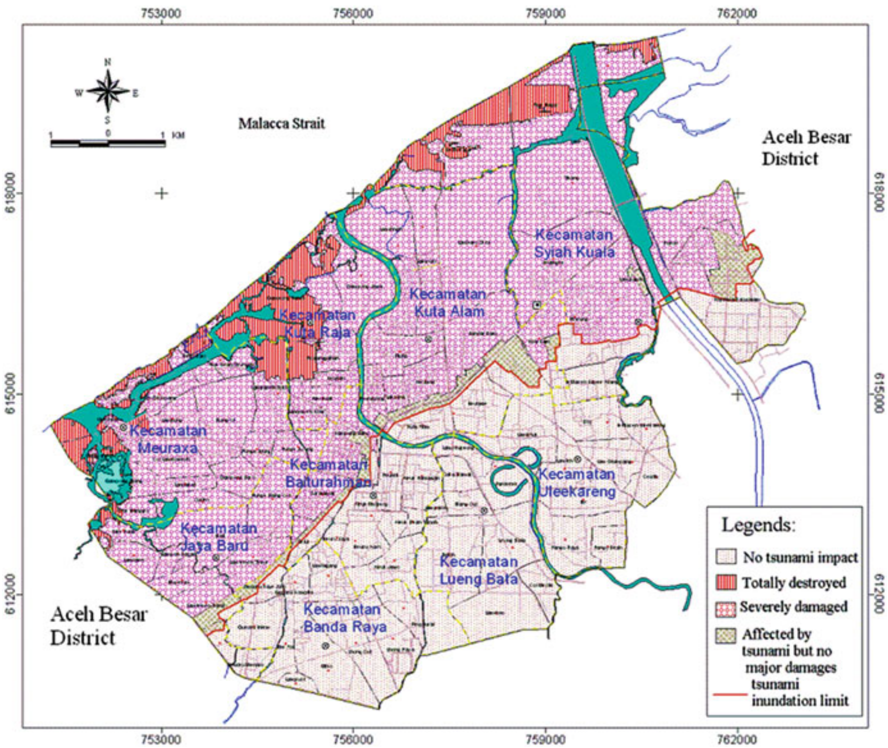

Fig. 16.3 Damage distributions in Banda Aceh due to the 2004 Indian Ocean tsunami (Modified from BPN NAD 2005)

impacts of the tsunami on the area. Large coastal populations were found around the coastal area of Banda Aceh before the 2004 tsunami, such as those who stayed around Meuraxa and Kuta Raja subdistricts.

During the rehabilitation and reconstruction process, BRR introduced a concept of land use planning for the city. The concept was released by Indonesia National Development Planning Agency (BAPPENAS) in April 2005, and it was called as "blueprints." This was aimed to be a formal guidance for the rehabilitation and reconstruction process to all related stakeholders, especially to BRR. In terms of spatial planning, it was planned that Banda Aceh was classified into three zones, i.e., conservation zone, restricted development zone, and promoted zone (BAPPENAS 2005). The restricted development zone covered almost all coastal villages at four subdistricts, i.e., Meuraxa, Kuta Raja, Kuta Alam, and Syiah Kuala. During the first year of the rehabilitation and reconstruction process, a top-down method in managing the restricted development zone was introduced. In this top-down method, BAPPENAS put a restriction of any development within 2 km of the shoreline. This strictly regulated zone was aimed to be a tsunami buffer zone. Just a month after the "blueprints" was released, USAID started its contribution for housing reconstruc-

Fig. 16.4 (**a**) Houses around coastal Area in *Kecamatan Meuraxa* of Banda Aceh. (**b**) A coastal lagoon in *Kecamatan Kuta Alam* of Banda Aceh has been recovered, and a number of coastal forests can be found around this area

tion by adopting "bottom-up" method. The bottom-up method implemented by the USAID allowed demands and requests voiced by the affected coastal communities. Later, the method was also adopted by many agencies/organizations who involved in housing reconstruction projects in Banda Aceh and in other tsunami-affected areas. Since most of the coastal communities were fishermen, a large number of the communities requested their houses to be built at the coastal area, where they lived before the tsunami 2004. The positive outcome of the bottom-up method is this method led to a high ownership of the reconstruction process. The reconstructed house owners could express their views during the process. Complaints from the recipients were minimum compared to the top-down method. However, on the negative side, the bottom-up method faces difficulties to apply the concept of the blueprints. This resulted in a large number of reconstructed houses that could be seen in the restricted zone (Matsumaru et al. 2012). Pictures of the houses that were built in Ulee Lheue village of Kecamatan Meuraxa, where it was supposed to be a restricted zone, can be seen in Fig. 16.4a. Meanwhile, lagoons and swamp area around Banda Aceh coast have been recovered, and a group of coastal vegetation, such as mangrove forest and *Casuarina* sp., can be found around the area (see Fig. 16.4b).

In general, during the rehabilitation and reconstruction process, the built-up area of Banda Aceh grew about 20 %, and no significant change was identified for vegetation land use unit (Ahmad 2013). The large contribution of the built-up area came from housing and urban infrastructure. Due to the tsunami, Banda Aceh lost about 111 Ha of its mangrove area and 427 Ha of its pond area (Wibisono and Suryadiputra 2006). After the BRR completed its works in 2009, the land use changes in Banda Aceh reached a rather stable phase. The destroyed ponds and lagoons around Banda Aceh have been seen to be recovered between 60 % and 95 % 10 years after the Indian Ocean tsunami (Syamsidik et al. 2014). However, to prevent a further complexity of the Banda Aceh land use and to maximize the opportunity to adopt tsunami mitigation measures in terms of land use, the Government of Banda Aceh has released the Banda Aceh Spatial Planning under a bylaw (in local Aceh's context, a bylaw in Aceh is called as *Qanun*. The word was derived from Arabic word) No. 4 Year 2009.

The *Qanun* specifically mentioned that one of the spatial planning's objectives enacted in the *Qanun* was aimed at developing Banda Aceh to be a city that adopts disaster mitigation. This is considered a significant change in terms of spatial planning regulation that was not found before the 2004 Indian Ocean tsunami. The spatial planning is targeted to regulate the land use of the city between 2009 and 2029.

In previous spatial planning regulation, Banda Aceh had one central business district (CBD) that was located just in the middle of the city (conjuncture of Kecamatan Baiturrahman, Kuta Alam, and Kecamatan Kuta Raja). With the new *Qanun*, Banda Aceh decided to have one additional CBD that is located between Kecamatan Lueng Bata and Kecamatan Banda Raya (see Fig. 16.5). With this multiple CBDs concept, Banda Aceh tries to adopt the disaster mitigation by not only for zoning the city area but also restructuring the spatial planning of the city.

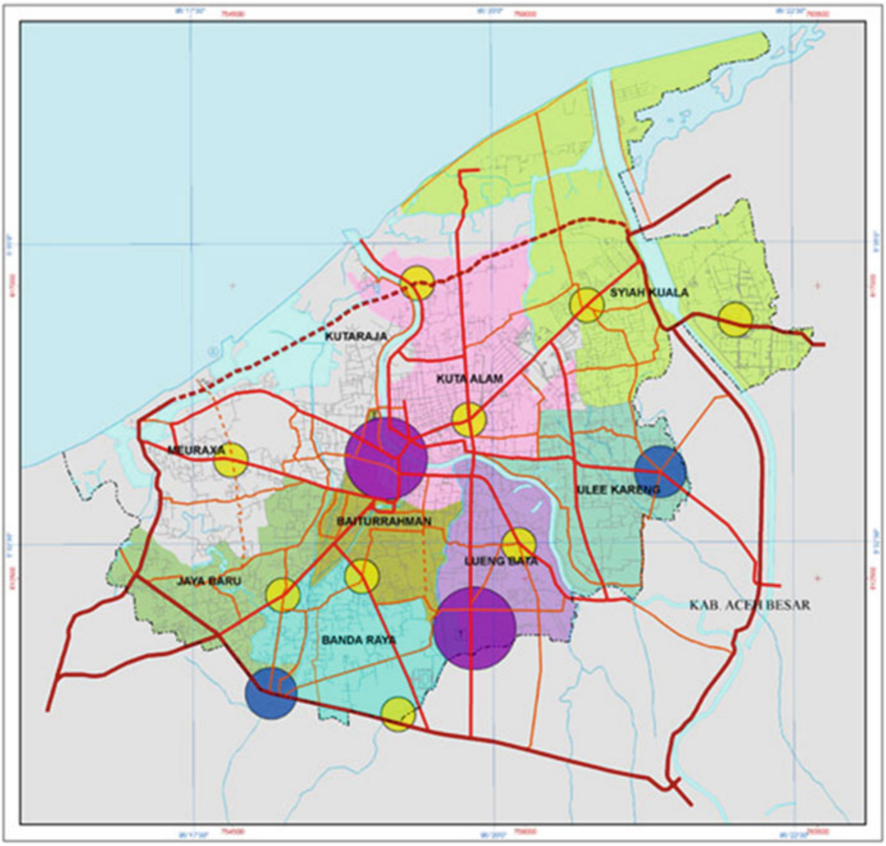

Fig. 16.5 Spatial structure of Banda Aceh according to Banda Aceh spatial planning for 2009–2029. *Maroon circles* represent CBDs, while *blue circles* represent sub-CBDs (PEMKOT Banda Aceh 2009)

According to the *Qanun* too, Banda Aceh is planned to allocate about 21 % of its area to become a conservation area. The conservation area consists of river embankment, mangrove forest, green open space, and cultural heritage sites.

16.4 Land Use Changes in Meulaboh

Meulaboh is the capital city of West Aceh district. The city administrative area covers only one subdistrict (*Kecamatan*), that is, *Kecamatan Johan Pahlawan*. Before the tsunami Meulaboh had a population about 52,118 people. The city lost about 10.4 % of its population due to the tsunami (Rofi et al. 2006). According to population census in 2013, the population of Meulaboh City in that year reached about 60,990 people (BPS Aceh Barat 2014). A number of migrated populations were also triggered by the opening of new companies around the city, such as coal mining companies and an electric power plant company that attract people to migrate into the city recently. Meulaboh City has an area about 44.9 km^2. The Meulaboh City is divided into 21 villages. Six villages in the city are located around 1 km from coastal line, and they were severely destroyed by the 2004 Indian Ocean tsunami. Most of the economic activity in this town still relies on small merchants and fisheries.

Due to the tsunami, about 3897 units of buildings were damaged, 100 % of agricultural land inside the city was damaged, and it eroded about 0.734 km^2 of the city area or about 1.64 % of the city's area before the Indian Ocean tsunami (Wikantika et al. 2011). Based on GIS analysis from two periods of satellite images (i.e., captured in May 2004 and in 2014), the land use changes in Meulaboh can be found significant in the six coastal villages. The number of houses was decreased. However, at other 15 villages, the land use changes could not be clearly identified, in terms of number of units and in terms of type of the land use (see Fig. 16.6). Comparing the two images, the land use areas used for government and education facilities (schools and offices) in Meulaboh within 1 km from coastal line are relatively unchanged. However, we identified that the market or shopping lots in Meulaboh have shifted farther away from coastal area.

Relocation of the coastal communities could be made partially at all six coastal villages. Among the six coastal villages, only one successfully was being relocated to non-tsunami-affected area, that is, Gampong Padang Seuraheet. The other coastal villages could not be relocated fully to the non-affected area due to several reasons. Among the reasons was the difficulty of the government to procure sufficient land at the non-tsunami-affected area. Soon after the tsunami, the land price at the non-affected area increased significantly. This made the local government failed to secure the land for the relocation program as requested by the reconstruction and rehabilitation donors. Other reasons were found to rely on the household main job connection as fishermen who are reluctant to be away from coastal area.

In order to control the future land use development in this city, the West Aceh District Development Planning Agency (BAPPEDA West Aceh district) formulated a spatial planning for the West Aceh district. The spatial planning has been enacted

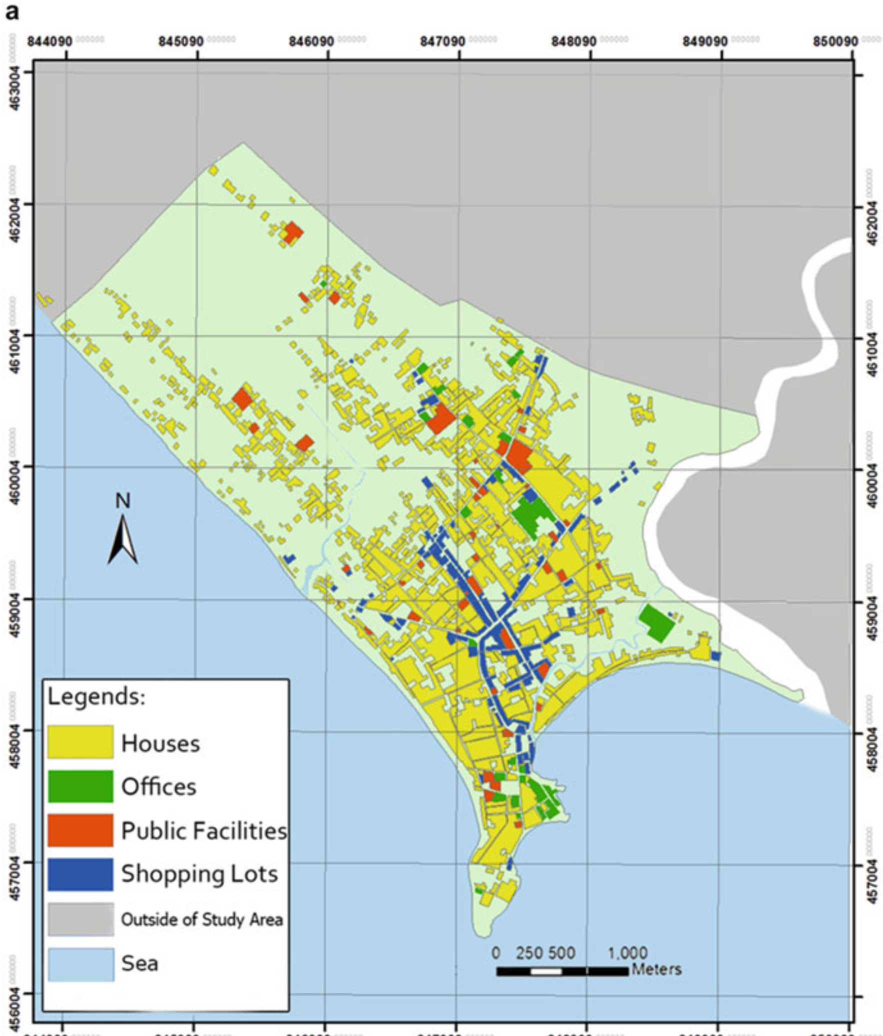

Fig. 16.6 Comparison of land use in Meulaboh (**a**) before the tsunami, analyzed based on image captured in May 2004, (**b**) 10 years after the tsunami, analyzed based on image captured in 2014

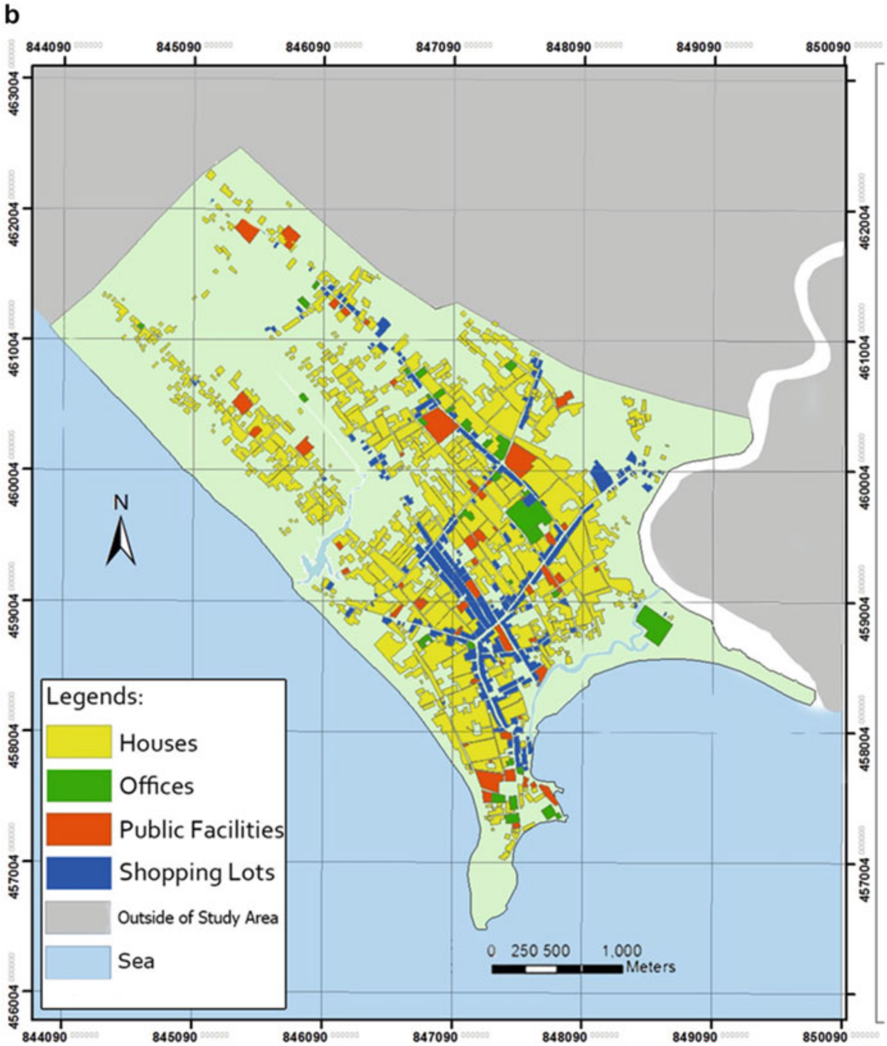

Fig. 16.6 (continued)

in the District Law (*Qanun*) No. 1 Year 2013. The spatial planning regulation is aimed to be a guidance for this district in the district development, investment, and disaster mitigation for the period between 2012 and 2032. In this regulation, the government addresses the needs of this city to develop evacuation routes and tsunami shelters and to develop tsunami mitigation-related infrastructures. Based on this spatial planning regulation, now the Meulaboh City has designed ten evacuation routes and eight tsunami shelters to facilitate the people. In addition, the government also regulates mitigation-based spatial planning for other types of disasters, such as flood and fire (PEMKAB Aceh Barat 2013).

16.5 Land Use Changes in Mentawai Islands

The Mentawai Islands has 98 small islands where only four of them are inhabited islands, namely, Siberut, Sipora, North Pagai, and South Pagai Islands. Administratively, the Mentawai Islands are also part of West Sumatra province. Unlike community who resides in the main island of West Sumatra province, the people of the Mentawai Islands have different culture and tradition. On October 25, 2010, the Islands of Mentawai were shaken by a 7.7 Mw. The earthquake later generated a tsunami that affected most of western coastal villages of the Islands. The tsunami resulted in 509 dead people and thousands of houses damaged by the earthquake or by the tsunami waves. Although the source of the tsunami was close to the coastal villages, the number of damages and human casualties was smaller than it was predicted. A study was conducted in 2011 to investigate the interventions made before the tsunami at this area. It was found that several coastal villages have rearranged its land use following suggestions made by the local Government of the Mentawai Islands. Houses near the coastal line were relocated to higher land or a few hundred meters from the coastal line. The decision was made after the coastal village's internal discussions that were inspired by the 2004 Indian Ocean tsunami. As the Mentawai Islands' communities are rather disconnected from news or electronic media, information received by the coastal communities reached in a rather slow phase. Interestingly, the 2004 Indian Ocean tsunami did give a strong motivation to the community to rearrange their village land use. However, some *Dusun* (*Dusun* is a local term for a hamlet) did not follow the program. This contributed to the high number of human casualties, such as those were recorded from Dusun Sabeugunggung of North Pagai Island. Details of the relation between the spatial planning intervention made before the 2010 tsunami and the human casualties can be read from Syamsidik and Istiyanto (2013).

Rehabilitation and reconstruction process in the Mentawai Islands was done in 3 years, started from 2011 to 2013. The rehabilitation and reconstruction process refer to a decree from the Head of Indonesia National Disaster Management Agency (BNPB) No. 3 Year 2010. In the decree, it was stated that revision should be made on spatial planning of the Mentawai Islands to adopt disaster mitigation that was not part of the previous spatial planning document (BNPB 2011). However, until March 2015, the spatial planning of the Mentawai Islands still could not be completed for several reasons. One of the most concerning reasons was an initiative to change the land use of Siberut National Park that has been challenged by many parties. Relocating people from coastal area of the Islands is not an easy job due to the limited spaces available in the small islands. The relocation will also mean moving the people to the hinterland of the island that could trespass the National Park territory.

16.6 Conclusions

After the 2004 Indian Ocean tsunami, Indonesia has adopted a series of new policies to regulate its land use to allow ample rooms for disaster mitigation in the spatial planning. At national level, three national laws have been enacted in 2007 by incorporating a significant portion of new disaster management paradigm into them. Land use in Indonesia has been very much influenced by the 2004 Indian Ocean tsunami. The tsunami gave an important example where types of land use, spatial planning, and the implemented regulations contributed to the damages and losses caused by the disaster. The land use changes are hardly expected when it comes to housing complex. It is related to the economic activity of the people who mostly are fishermen. Challenges to relocate the coastal communities are obvious. In Banda Aceh and Meulaboh, the two cities that were severely affected by the tsunami, a significant number of coastal populations are still found. Fortunately, the local governments offer another alternative to facilitate tsunami disaster mitigation by constructing evacuation routes, tsunami shelters, and other tsunami mitigation infrastructures. It must be noted that the efforts should be continuous and monitored to ensure the sustainability of the mitigation at the tsunami-prone area. The land use changes in the Mentawai Islands that were performed between 2007 and 2010 were found to contribute positively to prevent large number of human casualties. This was found after the 2010 Mentawai tsunami. A future development of the land use in Indonesia relies on the consistent campaign and advocacy on disaster mitigation-based spatial planning that has been regulated in a number of new enacted laws and policies.

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Chapter 17
Land Use and Land Cover Change Analysis Using Multi-date Multispectral Satellite Data: An Integrated Study of South Chennai in Tamil Nadu State, India

M. Arunprakash, M. Jayaprakash, S. Nethaji, and R.R. Krishnamurthy

Abstract Cites are the attraction for the growth of the social, economic, and political development of the country. It has a power for the development of large-scale and small-scale industries, educational institutions, administrative offices, public and commercial establishments, etc. In turn it attracts more migration from the rural area to the urban area or shifting from one urban center to another urban center. Hence the population density is getting magnified in certain pockets of the cities. As a result there would be a drastic conversion and modification in usage of land. Therefore, there should be a definite analysis and various assessments are required for such a development and also to preserve the city environment including preparation for future disasters. South Chennai is a part of Chennai City, which is the capital of Tamil Nadu and one of the four major metropolitan cities in India, located in the southeastern India. The average population growth rate of the Chennai Metropolitan Area (CMA) is 21 % per decade that recurrently reduces the green-covered area. Exceptionally, during the post-economic liberalization period, i.e., between the years 1997 and 2007, most of the agricultural lands and other natural land covers are being converted to developmental activities such as industrial including information technology and information technology-enabled services (IT and ITES) sectors. Also the CMA has become a major hub for higher education and specialized health-care facilities, inviting increasing population both from various parts of the country and abroad. During the last 2004 Indian Ocean tsunami and the subsequent cyclones, the study area has witnessed with devastation in terms of life loss, infrastructure, and environmental quality. Therefore, it is essential to assess the land use/land cover changes and its associated environmental parameters using technology tools like remote sensing data and GIS. Land use/cover information are derived from PAN plus LISS data of IRS 1C and IRS 1D for the pre- and post-2004 Indian Ocean tsunami years, i.e., 1990, 1998, and 2005, in order to demarcate vulnerable sites and to focus on our future disaster risk reduction (DRR) activities.

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Keywords Land use • Land cover • South Chennai • Remote sensing • GIS

17.1 Introduction

Urbanization is one of the most widespread anthropogenic causes of the loss of arable land (Lopez et al. 2001), habitat destruction (Alphan 2003), and the decline in natural vegetation cover. It has been closely connected with industrialization and other socioeconomic characters. In India 79 million people lived in urban areas in 1961, but this figure has reached to 285 million people in the year 2001 (Rahman et al. 2011). The metropolitan cities are magnified spatially, and large areas are being transformed into built-up areas such as colonies, industrial development, and infrastructure projects. Urban land use expansion is driven by population growth and social and economic development (Shenghe and Sylvia 2002). As urban population increases, the demand of land for various urban activities also increases. Various studies have revealed that the main basis of urbanization is the socioeconomic transformations and in particular the growth of secondary and tertiary occupation in urban areas (Fazal 2001). Therefore, the increased rate of population in major cities has led to many environmental and socioeconomic consequences like urban expansion, inadequate housing, poor transportation system, poor sewerage, erratic electric supply, insufficient drinking water, etc.

The environmental factors such as soil characteristics, climate, topography, and vegetation (Muthusamy et al. 2010) are factoring the land use. A modern nation, as a modern business, must have adequate information on many complex interrelated aspects of its activities in order to make decisions. Land use is only one such aspect, but knowledge about land use and land cover has become increasingly important as the nation plans to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands, and loss of fish and wildlife habitat. Land use data are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current levels (Anderson et al. 1976). One of the prime prerequisites for better use of land is information on existing land use patterns and changes in land use through time. Knowledge of the present distribution and area of such agricultural, recreational, and urban lands, as well as information on their changing proportions, is needed by legislators, planners, and state and local governmental officials to determine better land use policy, to project transportation and utility demand, to identify future development pressure points and areas, and to implement effective plans for regional development. Clawson and Stewart (1965) have stated: “In this dynamic situation, accurate, meaningful, current data on land use are essential. If public agencies and private organizations are to know what is happening, and are to make sound plans for their own future action, then reliable information is critical.”

Remote sensing in urban and near urban areas is influenced by a complex assemblage of disparate land covers which form a heterogeneous agglomeration of targets resulting from human activities, vegetation types, and soil and water bodies (Forghani 1994). As with many mapping problems, urban classes are represented by a continuum of cover classes rather than possessing well-defined boundaries (Forster 1980). Forster (1985) opined that the applications of remote sensing approaches to urban studies are useful because they can provide regular and rapid updating of land use data and are spatially more relevant for reporting urban development than census-type statistical data.

The information derived from remote sensing data is validated by systematic ground verification. Satellite remote sensing provides multispectral, multi-spatial, multi-temporal data useful for resources inventory, monitoring, and their management. Trotter (1991) indicated that remote sensing could provide a very cost-effective data acquisition and interpretation source for geographical information systems while at the same time providing that data are current, sufficiently accurate, comprehensive, and available to a uniform standard over the entire area of interest. Traditional collection of biophysical parameters in coastal areas (especially by ground- or sea-based system) is expensive and time-consuming, and the information available to key users is often incomplete and inadequate (Scialabba 1998). Analysis of remote sensing data in consultation with the Survey of India (SOI) topographical maps can provide an important input to GIS. In this study, therefore, remote sensing and GIS techniques have been used to study the land use and land cover changes.

17.2 Study Area

The study area covering the southern part of Chennai and part of its suburbs is located adjoining the Bay of Bengal, on the east coast of India (Fig. 17.1), and lies between 12°47′ N 80°15′ E and 13°00′ N 80°05′ E. It forms part of the Survey of India toposheet. The area investigated is ~60 km^2. Chennai is a metropolitan area (Fig. 17.2) and is comprised of Chennai City Corporation, 16 municipalities, 20 special grade village panchayats, and 214 villages. The urbanized area extends approximately 50 km, north to south, and 30 km east to west. Like other large Indian cities, Chennai is growing fast economically and demographically. The city has a diversified economic base with well-developed industrial and tertiary sectors. Chennai is the main automobile production and assembly center in India, and it is gaining momentum as a back office and IT center. Two rivers meander through Chennai: the Cooum River (or Koovam) in the central region and the Adyar River in the southern region. Both rivers are heavily polluted with effluents and trash from domestic and commercial sources. The Adyar, which is much less polluted than the Cooum, is desilted and cleaned periodically by the state government. The main objective of the study is to analyze the nature and extent of land use/land cover changes of the study area for two decades.

Fig. 17.1 Location map for rapid urbanization areas and need for urban management plan options

17.2.1 Demography

The demographic profile of the Chennai Metropolitan Area (CMA) (Table 17.1) has grown from a population of 35.06 lakh in the year 1971 to 70.41 lakh in the year 2001. The city population has grown from 26.42 lakh in the year 1971 to 43.43 lakh

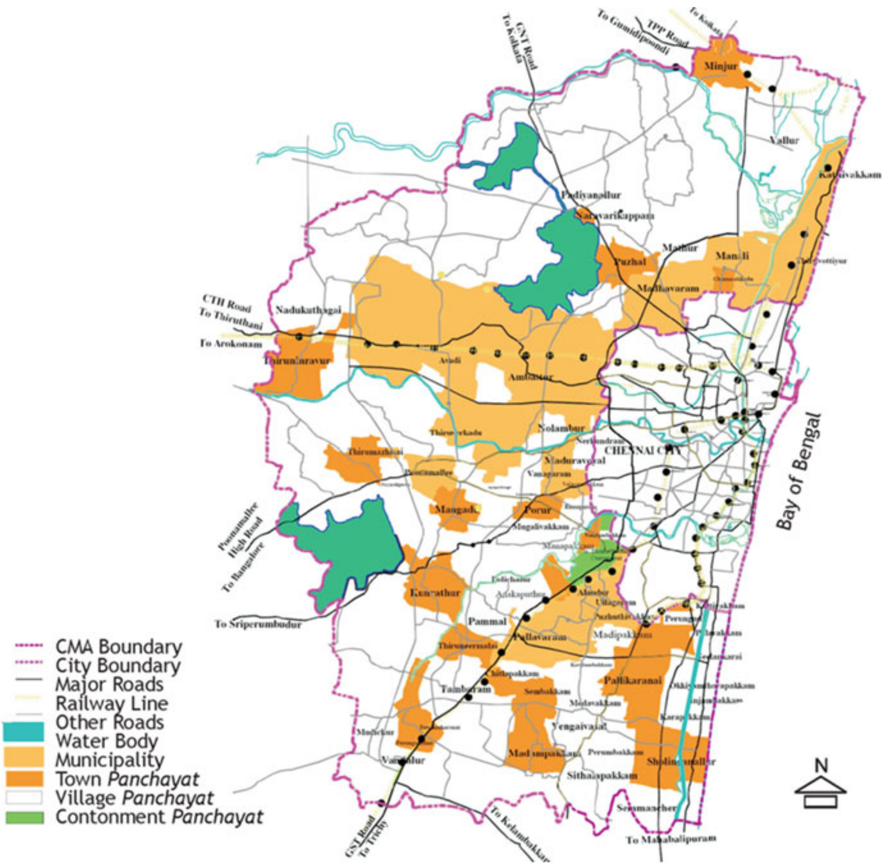


Fig. 17.2 Chennai Metropolitan Area map

Table 17.1 Growth of population and population density in Tamil Nadu, Chennai City, and CMA during 1971–2001

Sl. no	Description	Population (in lakhs)				Decadal growth rate %			Area sq.km	Density per Ha. in 2011
		1971	1981	1991	2001	1981	1991	2001		
1	Chennai city	26.42	32.85	38.43	43.43	24 %	17 %	13 %	176	247
2	Municipalities	4.84	8.14	11.84	15.81	68 %	45 %	34 %	240	66
3	Town panchayats	1.11	1.64	2.71	3.86	48 %	65 %	42 %	156	25
4	Village panchayats	2.67	3.38	5.2	7.31	27 %	54 %	41 %	617	12
5	CMA [total]	35.04	46.01	58.18	70.41	31 %	26 %	21 %	1189	59

Source: Census of India and CMDA, Second Master Plan for Chennai Metropolitan Area 2026

Table 17.2 Projected population for CMA and Chennai city (in lakhs)

Sl. No	Description	Actual	Projection				
		2001	2006	2011	2016	2021	2026
1	Chennai city	43.44	46.28	49.50	52.39	55.40	58.56
2	Municipalities	15.81	18.52	21.75	25.60	30.20	35.69
3	Town panchayats	3.86	4.73	5.89	7.41	9.45	12.22
4	Village panchayats	7.31	8.70	10.59	12.96	15.99	19.88
5	CMA [total]	70.41	78.96	88.71	99.66	111.97	125.82

Source: Second Master Plan for Chennai Metropolitan Area 2026

in the year 2001. The Second Master Plan for CMA 2026 has projected the population of CMA to reach 88.71 lakh in the year 2011, 111.97 lakh in 2021, and 125.82 lakh in 2026 (Table 17.2). The population of CMA is 11.28 % of the population of Tamil Nadu state as per 2001 census. The municipalities and town panchayats have experienced higher growth rate than that of the city. The density pattern indicates that the city has the highest gross density of 247 persons/ha, whereas the average gross density in CMA is only 59 persons/ha.

17.2.2 Recent Developmental Activities in South Chennai

The city is too growing to the south with development of commercial and residential space. Chennai, in recent decades, has been steadily growing southward—Adyar, Besant Nagar, Thiruvanmiyur—and now along the Old Mahabalipuram Road up to Siruseri over 30 km away. Since the late 1990s, software development and business process outsourcing and, more recently, electronics manufacturing have emerged as major drivers of the city's economic growth. Chennai has been rated as the most attractive Indian city for offshoring services according to A.T. Kearney's Indian City Services Attractiveness Index 2005. The city is now the second largest exporter of IT and IT-enabled services in the country after Bangalore, for example, the IT Corridor, on Old Mahabalipuram Road in the southeast part of the city, which houses several technology parks, and the Mahindra World City, a Special Economic Zone (SEZ) with one of the world's largest information technology parks in the outskirts of Chennai. More recently, Chennai has emerged as an electronic manufacturing hub with multinational corporations setting up electronics/hardware manufacturing plants, particularly in the Sriperumbudur Electronics SEZ.

17.3 Methodology

Chennai's land cover information for the years 1990, 1998, and 2005 was obtained from PAN plus LISS data of IRS 1C and IRS 1D, respectively. The land cover information was derived by means of digital image processing, which is mainly based on

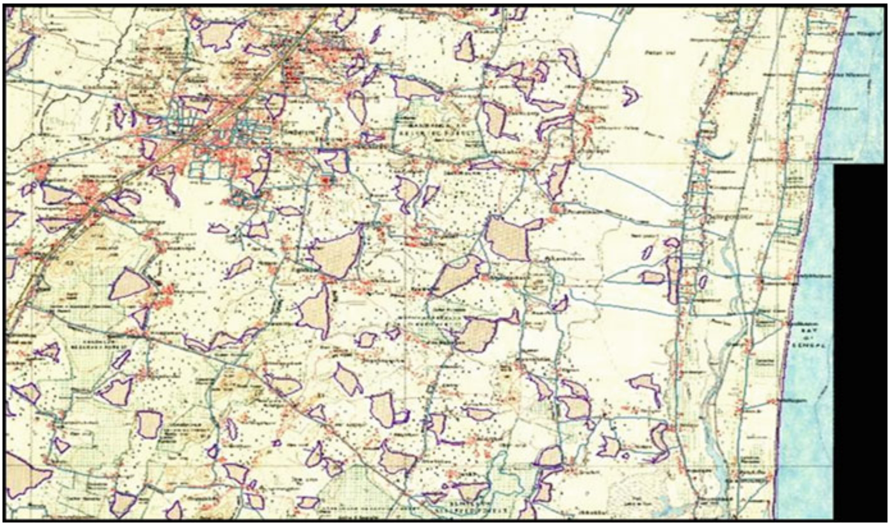


Fig. 17.3 Toposheet image of the study area

the spectral band reflectance of objects on this earth. The process of extracting the image of the study area involves two major steps: geometric correction and sub-setting. The geometric correction was done with the help of the geometric correction program of ERDAS Imagine software. The digitized Chennai City's topographic map (Source: Survey of India; Fig. 17.3) was used as a reference map for the geometric rectification of IRS 1C and IRS 1D satellite data (Fig. 17.4). The geographical spatial limit of the study area (the metropolitan area of the Chennai City) falls within 13° 06′ latitude to 80° 21′ longitude. Through sub-setting, the study area was clipped from the geometrically corrected IRS 1C and IRS 1D satellite data.

The processes of getting the land cover information involved extracting Chennai City's image, correcting geometrical distortion of Chennai City's image, and obtaining land cover information of Chennai City by on-screen digitization. The land cover information of Chennai City was derived by means of the supervised classification using ERDAS Imagine 8.5 software. The land cover classification was done in two steps: identification of training sets and classification of the image. The training sets were selected by two methods: polygon method and seed tool method. The training sets of the Chennai City were grouped into signature files: built and unbuilt lands, water bodies, forest areas, wetlands, road, beach, etc. The trueness of each training set was evaluated by checking its brightness count histogram at each band. The IRS 1C and IRS 1D satellite data were classified into nine major categories of land cover: densely built-up areas, sparsely built-up areas with vegetation, dense vegetation, inland water bodies, shrubs, ground cover, barren lands, marshy area, and sandy area.

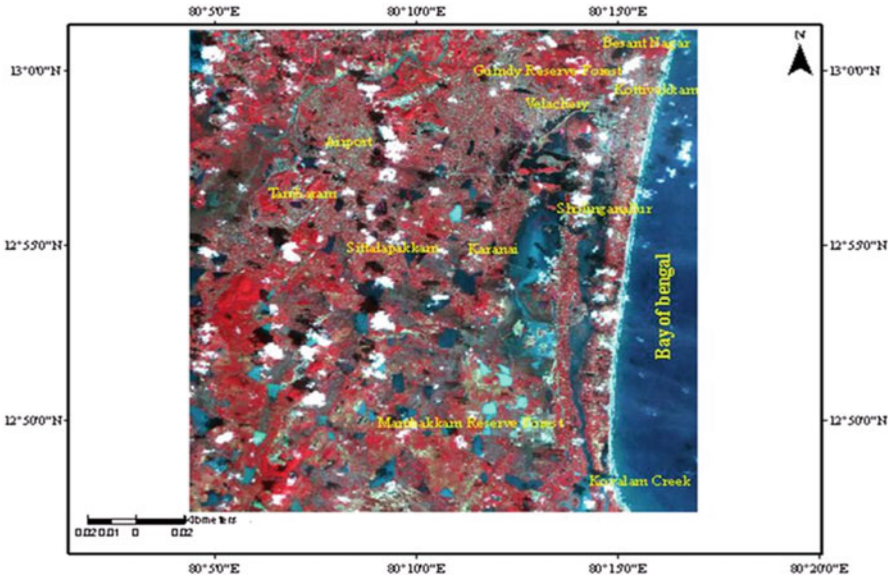
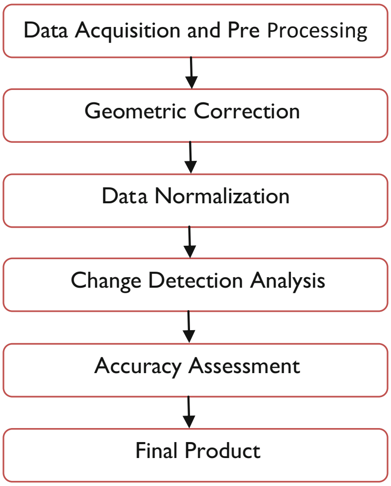


Fig. 17.4 Satellite image of south Chennai 2005



Flow chart of data processing elements for remote sensing change detection application

Changes in Chennai City's land cover during the years 1990, 1998, and 2005 were assessed with the help of Spatial Analyst of ArcGIS 3.2 and ArcGIS 9.1. Land cover data of Chennai City for the years 1990, 1998, and 2005 were reclassified into uniform pixel size at 5 × 5 m. Next, changes in Chennai City's land cover were evaluated location-wise by comparing the images with one another on a pixel-by-pixel basis. Geomorphology and land use/land cover maps were prepared by adopting the methodology developed by the National Remote Sensing Agency (NRSA) for nationwide land use and land cover mapping (NRSA 1999). SOI topographical maps of the south Chennai area prepared in 1976 were also used to correlate the land use/land cover changes.

17.4 Result and Discussion

Land cover refers to "natural vegetation, water bodies, rock/soil, artificial cover, and others, resulting to land transformations". Although land use is generally inferred based on the cover, yet both the terms land use and land cover being closely related are interchangeable. For example, vegetation as a cover for agricultural crop and for forest and the respective activity is classified based on the contextual evidence (NRSA 1999) as shown in Figs. 17.5, 17.6, and 17.7.

17.4.1 Land Use/Land Cover Change Detection

The 1976 toposheet and more recent IRS LISS-III imageries of 1990, 1998, and 2005 were used for the quantification of land use and land cover changes (LULC). Around eight classes were categorized for land use/land cover by comparing 1990, 1998, and 2005 data. There were noticeable changes in settlement areas in these 3 years.

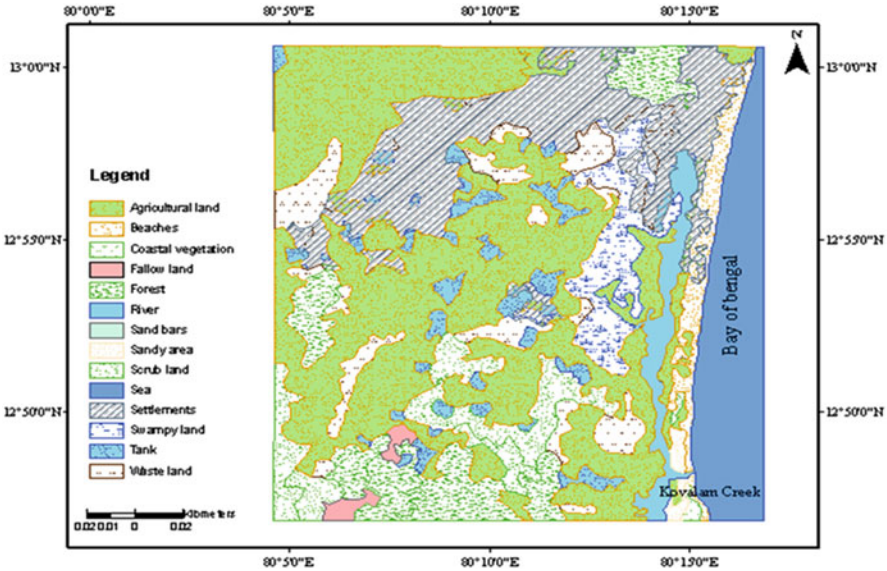


Fig. 17.5 Land use/land cover map of south Chennai—1990

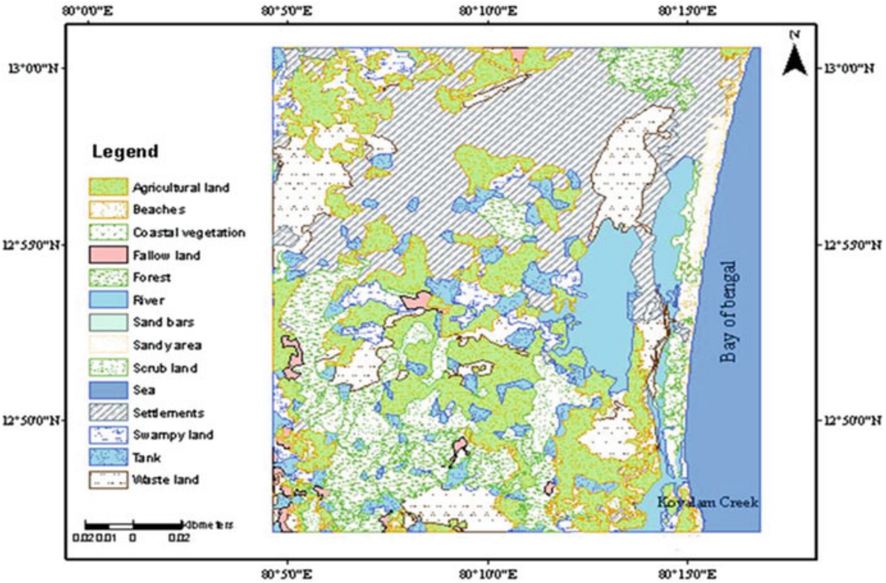


Fig. 17.6 Land use/land cover map of south Chennai—1998

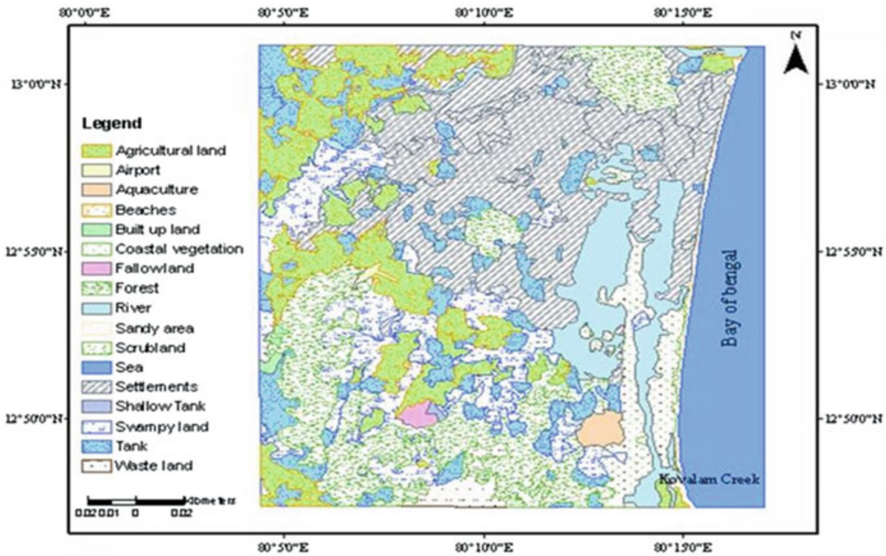


Fig. 17.7 Land use/land cover map of south Chennai—2005

Table 17.3 Land use/land cover changes during 1990, 1998, and 2005

Land use classes	Area in km²			% of total area			% of change 1990 versus 2005	% of change 1990 versus 1998	% of change 1998 versus 2005
	1990	1998	2005	1990	1998	2005			
Agricultural land	17.4	9.3	6	41	22	14	27	19	8
Settlements	7.5	10.40	11.5	18	25	27	9	7	2
Forest	3.8	4.5	6.8	11	14	16	5	3	2
Beaches	1.3	0.7	0.5	3	2	1	2	1	1
Swampy land	2.1	1.80	5.10	5	4	12	9	1	8
Tank	1.9	2.60	4.7	5	6	11	6	1	5
River	1.3	3.0	3.8	3	7	9	6	4	2
Scrubland	2.9	2.70	0.5	7	7	1	6	0	6

There have been contemporary changes in agricultural land area. In 1990, the area that was occupied by settlements was about 7.5 km^2; it was about 41 % of the total area. In 1998, the settlement area increased by 3 km^2 and reached a total area of 10.4 km^2. In 2005, it further increased and attained an area of about 11.5 km^2 (Table 17.3).

There was a gradual decrease in the area of agricultural land. In 1990, the total area of agricultural land was 17.4 km^2. It decreased to 9.3 km^2 in 1998. In 2005, the area of agricultural land was only 6 km^2. The forest area also increased. In 1990, the total forest area was about 11 % of the total area. During 1998, it increased by 3 % and reached 14 %. In 2005, the forest area was about 16 % of the study area. The Reserved Forest (RF) area has increased in 15 years span from 11 to 16 % due to customized forestry and intensified eucalyptus plantations in this area. The Velachery Lake has been converted into a settlement and the lake area has been reduced. The area of salt pan in Kovalam also decreased due to sudden development of urbanization and opening of few industries.

17.4.2 Changes in Coastal Geomorphological Setup

The changes/alteration of the geomorphological setup in south Chennai coast was studied in relation to existing land use. South Chennai coastal areas—Thiruvanmiyur, Kottivakkam, Reddipalayam, and Muttukadu—are located on the beach slope and sand dune complex. Casuarina plantations occupy major part of these coastal areas. Tirusulam and its surrounding areas are covered with pediment due to some inselbergs and structural hills present in that area. Some of the mudflats around Navalur and Pudupakkam areas are high potential zones for groundwater. In these areas, plantations like orchids and other cultivations are more common compared to other areas in south Chennai coastal region. Karapakkam, Okkiyam Maduvu, and

Thuraipakkam are situated on old beach terraces. These zones are also potential areas for groundwater exploration and more suited to forest plantations. Pediment zones nearer to Tirusulam area are not potential areas for groundwater due to the rocky nature of the area. Hence, cultivations are not dominant in these areas.

17.5 Summary

The remote sensing and GIS studies reveal that south Chennai area is undergoing rapid changes in land use and land cover due to urbanization and industrial developments. Quantitative estimation of land use/land cover changes derived from multi-date remote sensing data shows that the settlement areas increased, and there is a contemporary decrease in the agricultural land. Most of the pasture land in the study area, i.e., in and around Velachery, Pallikaranai, Perumbakkam, Karanai, Tambaram, Madipakkam, and Perungudi, is converted for new urban development. The intensity of urbanization in East Coast Road and Old Mahabalipuram Road has been increased after 1998. Severe alteration of inland freshwater bodies, especially in and around Velachery and Pallikaranai areas, reduced drastically mainly due to urbanization and denudation of lakes/ponds.

The remote sensing and GIS study results of this research shows the significant relationships between the green-cover change and the environmental performance change of the south Chennai City. The reserve forest area has increased in the last 15 years span due to customized forestry and intensified eucalyptus plantations in this area. Further, the output of this study will be a great help in identifying appropriate strategies to improve Chennai City's green cover. Nevertheless, this model could be repeated to other cities, by changing the parameters and input covers. It will help in understanding the spatial implications of the green-cover change on given city's environmental components.

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Chapter 18
The Great East Japan Earthquake and Tsunami: Lessons for Land Use

Yuko Araki, Akihiko Hokugo, and Satoru Masuda

Abstract In this chapter, we examined salient points during the reconstruction period in order to ensure security against future disasters and at the same time to restore people's lives and local communities lost in the disaster, through observation of land use management in the reconstruction after the tsunami caused by the Great East Japan earthquake (GEJE) in 2011.

In the first section, we overview the damage caused by the GEJE and the government's policies to deal with tsunami and point out issues regarding land use management in the period after the GEJE. Then in the second section, the fact that the larger the area of inundation in the region is, the slower the reconstruction work proceeds is presented from an analysis of the method and situation surrounding disaster hazard area designation. The pre-earthquake situation and the post-disaster policies to address tsunami in the afflicted areas are indicated in the third section. While the damage was reduced in the coastal plains in Sendai where development had been regulated, the Sanriku coastal region where reconstruction had been carried out repeatedly in the areas prone to inundation due to the need of using the coastal lands has suffered from disasters many times. It is indicated that disaster prevention policies depending on land use management alone can hinder the restoration of communities and people's lives. In the fourth section, we take approaches toward reconstruction in a couple of disaster-stricken cities as examples and discuss the necessity of improving the environment of the relocation sites to realize security and restoration. Land use of the original sites after the relocation, support of residents' evacuation, and methods to secure safety should be integrally planned, too. Consideration of comprehensive land use management and the importance of the revision process are discussed in Sect. 18.5 as a conclusion, and the potential of a

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bottom-up process of safety consideration through the formation of a community disaster management plan is suggested as a perspective for the future.

Keywords Disaster hazard area • Disaster prevention promoting group relocation • The Great East Japan earthquake and tsunami

18.1 Introduction

The tsunami caused by the GEJE and which hit Japan in 2011 was far greater than ever imagined, and the damage was extensive. After the disaster, the Government of Japan began to focus much more on disaster mitigation to reduce the damage rather than on disaster prevention to completely avoid the damage. The actual policy adopted was a two-stage method which categorizes tsunami into two levels depending on the scale and frequency and takes countermeasures accordingly. The tsunami disaster prevention measures in the actual reconstruction, however, have been practiced based on the idea which focuses on prevention of tsunami with a tide embankment and relocation from the flooded area with the preservation of local character reflected only within a limited scope.

Also because the reconstruction expenses of the embankment construction are borne by the national government as a part of post-GEJE reconstruction measures, the afflicted prefectures have been trying to adopt methods in which they can avoid to bear the expenses by implementing the project before the end of the period in which the subsidy is provided. Consequently more focus is placed on the prevention and avoidance of tsunami disaster in the safety measures with little local diversity taken into consideration. In turn, the reconstruction works themselves are delayed, and the local communities are put in danger of existence due to the outflow of population.

18.1.1 Outline of the Damage Caused by the GEJE

The 2011 off the Pacific coast of Tohoku earthquake with magnitude 9.0 centered offshore of Sanriku occurred at 14:46 on March 11, 2011. It was the tsunami generated by the earthquake that caused the greatest damage among the earthquake-triggered collapses, fires, landslides, land subsidences, liquefactions, and so forth. The tsunami hit the Pacific coast in and around the Tohoku region, causing tsunami fires and accidents at nuclear power plants and leading to heavy damage. The human toll in the GEJE was huge with 15,892 dead and 2574 missing in 12 prefectures. Totally collapsed buildings numbered 124,663, while 274,638 buildings were partially collapsed, and 746,870 buildings were partially damaged (National Police Agency 2015). The tsunami flooded a total land area of 561 km^2 in six prefectures (Geospetial Information Authority of JAPAN 2011).

In modern history alone, the Tohoku region has repeatedly experienced tsunami such as the Meiji Sanriku tsunami of 1896, the Showa Sanriku tsunami of 1933, and the Chilean tsunami of 1960 and suffered numerous casualties. Based on the damage experience in the past, there were tsunami disaster prevention measures such as damage estimation, construction of tsunami breakwater, and evacuation drills in the coastal areas in Iwate Prefecture and the northern part of Miyagi Prefecture in particular. The scale of the tsunami in the 2011 GEJE was, however, far bigger than the previous estimation. Although some researchers had pointed out the record of tsunami from the end of the ninth century which was quite similar in scale to the 2011 off the Pacific coast of Tohoku earthquake-triggered tsunami, not only residents but even the government administrations paid little attention. Not an earthquake or a tsunami of that scale had been expected.

18.1.2 Outline of Reconstruction Status and Land Use Issues

On April 14, 2011, after the GEJE, the Reconstruction Design Council in Response to the Great East Japan Earthquake was set up as a prime minister's advisory panel consisting of intellectual figures and governors of disaster-affected prefectures. In June 2011, after having held 12 meetings, the Reconstruction Design Council formed a list of recommendations on reconstruction planning. The report indicated the idea of "disaster mitigation" to reduce the damage to a minimum rather than to try to completely contain the natural disaster for the post-disaster reconstruction of local communities. The recommendations point out the importance of measures to avert disasters by way of land use and to support evacuation of the residents, as well as structural preventive measures such as tsunami barriers.

On April 27, 2011, the Committee for Technical Investigation on Countermeasures for Earthquakes and Tsunamis Based on the Lessons Learned from the 2011 off the Pacific coast of Tohoku earthquake was set up under the Central Disaster Management Council, a policy council in charge of disaster prevention in Japan. The Committee compiled an interim report on June 26 to recommend two-stage measures according to the frequency and scale of tsunami as the basis for tsunami disaster prevention policies in the future.

Based on the policies, the Ministry of Land, Infrastructure, Transport and Tourism; the Ministry of Agriculture, Forestry and Fisheries; and the Fisheries Agency issued a joint notice "Method to determine the design tsunami level." Then the prefectures simulated the estimated inundation based on the notice to suggest the height of coastal levees as mentioned in Sect. 18.2. Large-scale projects to relocate homes from the inundated areas have been proceeding, and the original sites are designated as disaster hazard areas by the municipalities under Article 39 of the Building Standards Act.

In some municipalities in which the central districts escaped major damage, reconstruction projects as town development plans have almost been completed after having merged residential districts which used to be dispersed and revitalizing the central districts. On the other hand, in the municipalities with central districts that suffered devastating damage and coastal regions where industrial and residential zones existed in a mixed fashion, reconstruction projects have been delayed. Especially in the cases where the central district was flooded and needs to be raised or relocation of residential zones from the coast to higher ground are involved, it has been becoming more and more costly and time-consuming. The delay of reconstruction projects causes the delay of the reconstruction of residents' lives, which accelerates the outflow of the rural population into Sendai and other urban districts for employment, causing the even more rapid aging of rural communities. In some group relocation projects, too, the number of those who wish to join the relocation plan has been decreasing because more people reconstruct their homes individually as the projects are postponed. Land use plans of the sites designated as disaster hazard areas, which comprise about one-third of the GEJE flooded area, have hardly proceeded. In Miyagi Prefecture, 40 % of these sites was left unplanned and with no prospective plan as of the end of March 2015 (Kahoku Shimpo 2015).

In the other regions in Japan like Tohoku where earthquakes and tsunami have periodically occurred, damage estimation has been reviewed by the national and prefectural governments after the GEJE that was far bigger than the previous estimation. It is required that the corresponding actions should be predicted on the premise that the area can be flooded by tsunami when tsunami disaster hazard areas are designated based on Tsunami Prevention Region Development Law issued in December 2011 after the GEJE and when a community disaster management plan is made based on the Basic Act on Disaster Control Measures amended in June 2013. Though they are trying to advance countermeasures accordingly, only a small percentage of relocation plans have been realized because people actually live there. Planning land use management with the possibility of disasters taken into consideration has not been undertaken either.

Also while the cost of embankment construction in the GEJE-affected area is covered by the national budget, it is carried out within a normal project scheme framework in the other areas. Therefore, in Kochi Prefecture, where a huge disaster is expected to be triggered by the Nankai Trough earthquake which is predicted to occur with a probability of 60–70 % within three decades, they lack the funds for embankment construction. It is predicted to take two decades from 2014 to build embankments strong enough to withstand an L1 tsunami. As observed above, there are gaps within Japan between the presented post-GEJE concept of safety and the reality and between the disaster-affected areas and other areas.

18.1.3 Previous Studies

As Japan has repeatedly experienced tsunami disasters in the past, research on land use management such as residence relocation has been carried out. Yaichiro Yamaguchi, a geographer from the Tohoku region, conducted a study on communities in coastal areas in Sanriku after the Showa Sanriku tsunami (1933) to show the conditions of community relocations which took place after the Meiji Sanriku tsunami (1896) and before the Showa Sanriku tsunami and illustrated the state of the disaster damage (Yamaguchi 1972b). Some of the communities which were relocated after suffering damage in the disaster began to come back to their original sites starting about a decade after the tsunami. Yamaguchi indicated poor geographical conditions such as the moving distance which was too far, a shortage of water resources, and separation from the main traffic routes as the factors behind the return to original sites. He furthermore pointed out more factors including economic reasons and ethnic psychology and stated that old communities existed within the geographical environment with natural and social restrictions (Yamaguchi 1972a).

Another study by Minami et al. on a town reconstruction plan in the Aonae area in Okushiri Island hit by a tsunami after the southwest-off Hokkaido earthquake (1993) shows the background of the planning (Minami and Oyanagi 1998). It reveals that what the fishery people wanted, in addition to anti-disaster measures, was important in making the reconstruction plan because it was essential to recover fishery, a key local industry; that restoration of the communities including residence relocations required coordination between the fishery production environment and tsunami-protection environment; and that because of those reasons, the residence distribution plan between upland and lowland changed at every step of the reconstruction plan, and the administration as the operating body researched and coordinated the desire of the residents. Minami also reported the state of Okushiri nearly two decades after the southwest-off Hokkaido earthquake to indicate that people felt the loss of the bustling atmosphere of busy streets since the commercial facilities were dispersed, though they gained safer lives by relocation to higher ground, and that the local reconstruction had been put in difficulty with continued depopulation and declining fishery industry (Minami 2012).

Regarding the post-GEJE situation, Masuda surveyed the disaster hazard area designation in Tohoku and stated the issues related the designation (Masuda 2014). He illustrated the situation of the special measures for the disaster prevention promoting group relocation in the Tohoku region which requires the area to be designated as a disaster hazard area and pointed out the possibilities of potential moral hazards caused by the situation. Also he pointed out the necessity of a framework to assess the impact of the disaster prevention-related regulations for planning the use of land such as the designation of disaster hazard areas and the necessity of identification of the risk level that the community would have to accept and consideration of cost-effectiveness and cost-benefit performance of facility construction.

Araki et al. have also been working at illuminating the current situation of disaster hazard area designation in GEJE-affected regions, as mentioned in Sect. 18.2 in this chapter, and indicated that the designation ratio in the flooded areas in GEJE is more related to the ratio of housing damage than to the ratio of human damage and that in the Sanriku coastal region, north of Oshika Peninsula, the lower the percentage of habitable area is in the district, the higher the designation ratio in the flooded area and percentage of houses totally collapsed are, so that it is hard to secure a relocation site, which in turn causes it to take even more time to reconstruct houses in the community (Araki and Hokugo 2014).

As can be seen, it has been repeatedly pointed out in the land use and reconstruction plans after tsunami disaster in the past that not only safety but also living and production environments are important and should be taken into consideration. The post-GEJE situations, however, indicate that the infrastructure construction projects for prevention and avoidance of tsunami disasters have been prioritized and the restoration of livelihood and community seems to be neglected until later.

In this paper, we examine how the post- and pre-disaster measures for the safety and existence of local communities should be worked on through disaster hazard area designation, changes in land use between before and after the disaster, and some actual examples of land use management.

18.2 Designation of Disaster Hazard Areas After the GEJE

Figure 18.1 shows the percentage of designated disaster hazard area in the flooded area by the GEJE in three Tohoku prefectures. Figure 18.2 indicates the relationship between the percentage of disaster hazard area designation and the percentage of the habitable land in the GEJE flooded area in different municipalities. Though they vary according to the variation in standard for designation by municipality, it is implied that the percentage of disaster hazard area designation is higher in the northern parts of Miyagi Prefecture and municipalities in Iwate Prefecture where the percentage of the habitable lands is lower than the middle and southern parts of Miyagi Prefecture and municipalities in Fukushima Prefecture where the percentage of the habitable lands is high. This shows that more relocation projects have been planned originally in the area with less habitable land. Specifically focusing on the safety aspect, it sounds natural to relocate houses from areas with a high risk of inundation. It is more difficult in such areas, however, to secure non-inundation land for relocation from the viewpoint of rehabilitation of people's lives, and it is expected to take a long time for the houses to be rebuilt. It has also become evident as shown in Fig. 18.3 that a delay in housing reconstruction of public works by district is occurring. We examined why such a situation happened from the fundamental approach to reconstruction work as indicated by the fact that the provision of housing lots and disaster public housing is much slower in Iwate Prefecture and the northern area of Miyagi Prefecture than it is in Fukushima Prefecture and the middle and southern area of Miyagi Prefecture where reconstruction started swiftly.

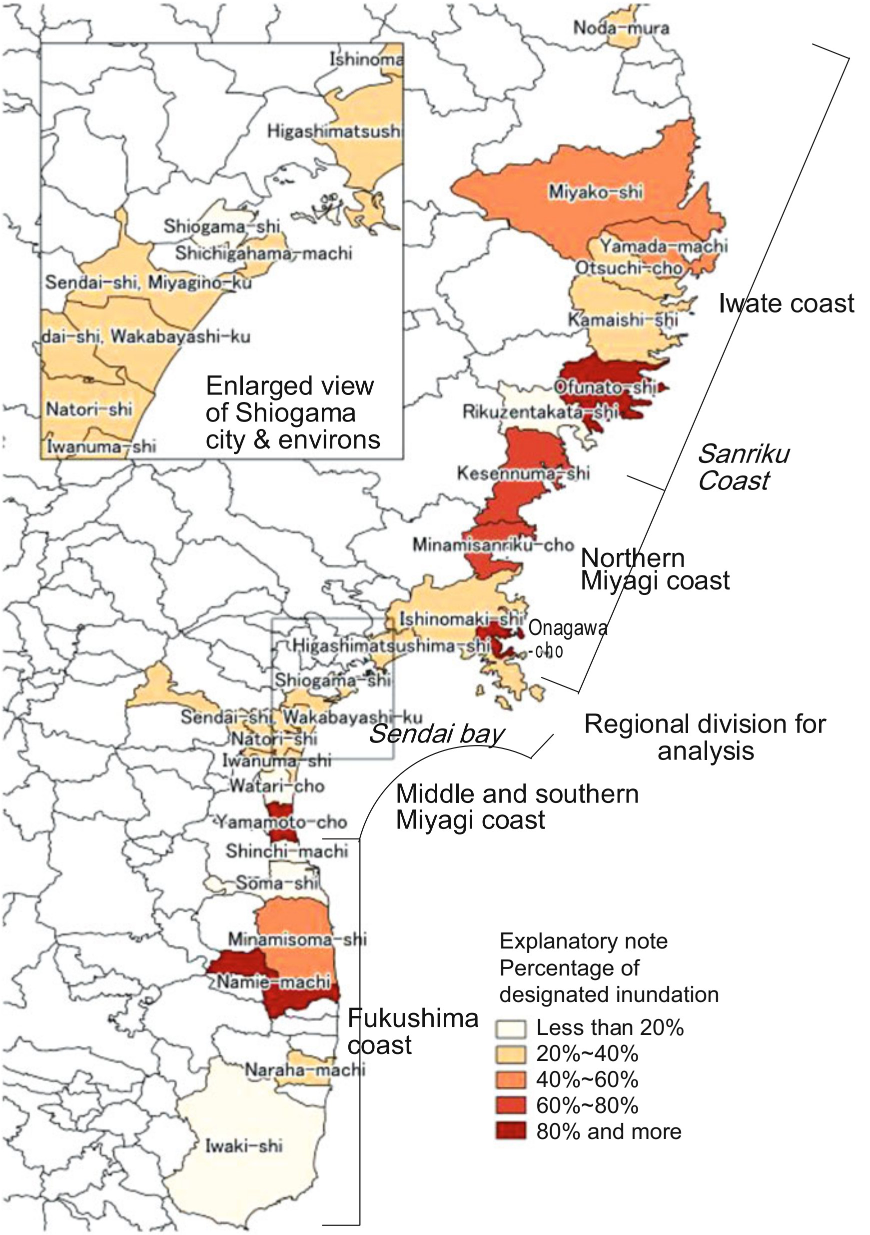

Fig. 18.1 Municipalities where disaster hazard area designations are performed and the ratio of the area to the flooded area in three Tohoku prefectures

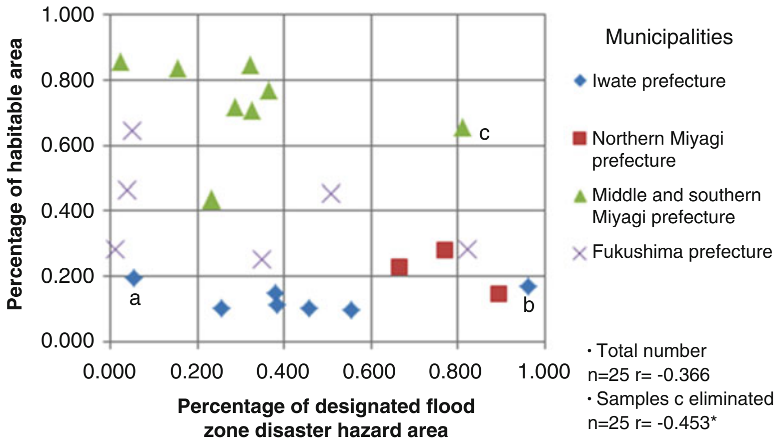

Fig. 18.2 Relationship between the percentage of designated flood zone disaster hazard area and habitable area by prefecture

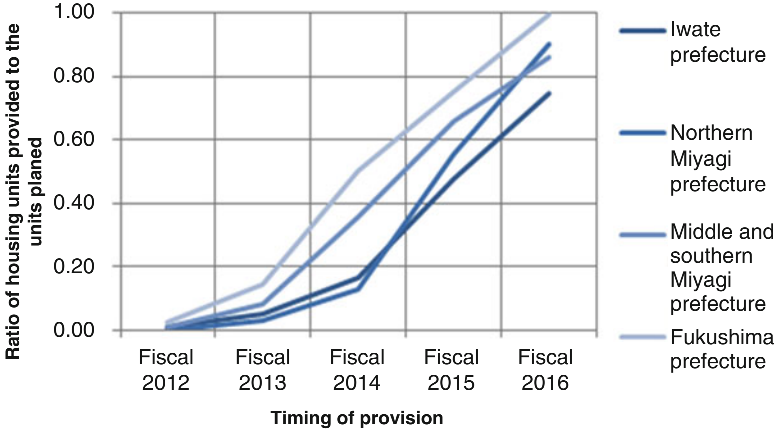

Fig. 18.3 Timeline for providing public disaster housing and land lots for private housing with surface maintenance works (From: Process Sheet of Housing Reconstruction as of the end of March 2015, Reconstruction Agency)

18.2.1 Two-Stage Tsunami Disaster Prevention Measures and Designation of Disaster Hazard Area

The national government has issued countermeasures which divide tsunami in two levels based on the recommendation by the Reconstruction Design Council and the Committee for Technical Investigation at the Central Disaster Management Council. This is similar to the approach to decide the acceptable probability of flood frequency based on the basin area and the degree of importance of the river depending

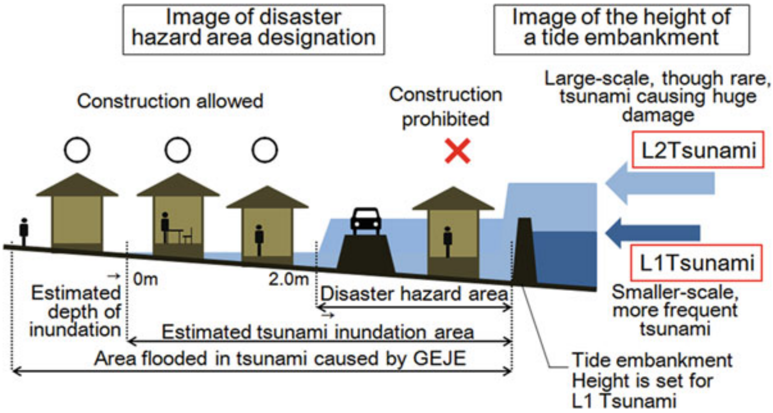

Fig. 18.4 Disaster hazard area and house reconstruction (with secondary levee)

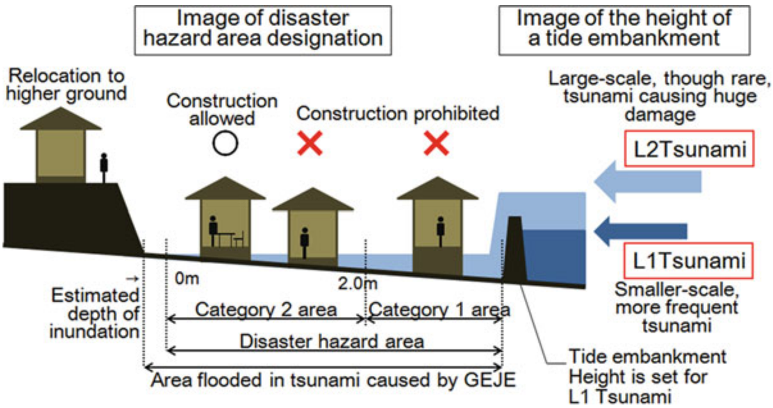

Fig. 18.5 Disaster hazard area and house reconstruction (without secondary levee)

on the area-wide urbanization and to the approach of seismic design for buildings which divide safety in two stages. As Japan is an earthquake-prone country, economic sustainability is undermined if buildings also collapse every time an earthquake occurs, though it goes without saying that protection of lives is also essential. Therefore it is required to make buildings which will not be destroyed, on top of securing the safety of human lives against earthquakes at levels which often occur. On the other hand, excessive funds are needed to equip buildings with utmost protection against a rare, giant earthquake. So what is required is a tenacious structure that does not easily collapse but surely gives people inside enough time to evacuate even if the building gets damaged.

Likewise, in the case of tsunami, inundation should be prevented to protect lives and property in tsunami that happens once every few decades to over a hundred years (L1 tsunami). When inundation is inevitable, human lives should be secured with land use management plans, land raising, and evacuation in a tsunami that rarely happens but causes huge damage when it occurs once every few centuries to a thousand years (L2 tsunami). In the directly afflicted areas, however, estimated tsunami inundation areas are under residency restrictions, and in some areas, there are no residents at all.

One of the reasons that large areas in the afflicted regions have been designated as disaster hazard areas is the designation method. While designation is made based on the record of damage in some cases, in almost all the municipalities, tsunami inundation simulation is used to designate disaster hazard areas.

First, the height of the levee is set to block an L1 tsunami; then the areas estimated to be inundated by an L2 tsunami that would overflow the levee are designated as disaster hazard areas. It means that the standard for the designation is based on the depth and the area of the inundation; the original use of the land and how easy to evacuate from the area are hardly taken into consideration (Figs. 18.4 and 18.5).

18.2.2 Designation of Disaster Hazard Area: Relationship with Relocation Projects

There is another factor besides the calculation method for the designation behind the fact that the disaster hazard areas have become so large. It is the relationship with the relocation projects for disaster-afflicted houses.

The main method used for house relocation in the process of reconstruction after the GEJE has been the disaster prevention promoting group relocation. However it requires that the original site after the relocation be designated as a disaster hazard area. A project to promote group relocation for disaster prevention is implemented based on the Act on Special Financial Support for Promoting Group Relocation for Disaster Mitigation, which was established after the torrential rain disaster that affected the area from Kyushu to Tohoku in 1972. Though it originally aimed to promote relocation from a high-risk area before a disaster happens, in reality it is implemented mostly after a disaster strikes. Also many of the group relocation cases carried out before the GEJE were from land near a cliff, land with high risk of river flood, or mountainous districts. It was also a measure to deal with depopulation, and it was not required to utilize the original sites.

In the case of the GEJE, however, it was expected that a huge area of land would be targeted for promoting relocation, so the central government reiterated that the municipalities should be able to use or lease the lots that municipalities bought or transfer or trade. Designation of disaster hazard areas by the Building Standards Act prohibits the areas from residential use, but not from commercial or industrial use. The disaster-affected municipalities, therefore, have been trying to find a way to utilize the extensive amount of land that they bought. However in the situation in which both the population and economy have been on a decline in Japan, especially in rural regions, and sufficient project funds are unavailable, no more than half of the needed planning has taken place.

Having thus observed the situation of designation of disaster hazard areas and its background, it is indicated that the land use management has been based on inundation estimation only.

18.3 Land Use for Tsunami Disaster Prevention Before and After the GEJE

The use and the shape of land are closely related in the first place. The coastal regions in Tohoku can be roughly categorized into five groups from north: (1) coastal terrace lies between the southeast of Aomori and north of Miyako City, Iwate; (2) rias coastline (deeply indented coastline) continues from south of Miyako City, Iwate, to Oshika Peninsula in Ishinomaki City, Miyagi; (3) an alluvial plain extends from Ishinomaki Plain which is west of Oshika Peninsula to the middle of Soma City, Fukushima, along the greater Sendai Bay; (4) hilly area continues from the middle of Soma City to north Iwaki City; then (5) another alluvial plain spreads in Iwaki City. In this section, we examine the situation before the earthquake and the response to the tsunami after the earthquake in the (2) rias coastline in the Sanriku coastal region and (3) the alluvial plain along the Sendai Bay.

18.3.1 The Situation in the Sendai Bay Area

The Sendai Bay area, which had not experienced severe damage by tsunami for a long time compared to the Sanriku coastal regions that have been frequently hit by tsunami, suffered GEJE damage in farmlands, scattered settlements, fishing port areas, and industrial areas.

In Miyagi Prefecture, the economy has developed with Sendai City, the biggest city in Tohoku, as its center. Through its history, inland of Sendai has been urbanized, and coastal areas at the middle of the Sendai bay region, with the exception of the area right around the port, have been utilized for agriculture, mainly as rice paddies. A wide coastal area in Sendai City has been the target of urbanization control to be preserved as farmland, and developments into housing or urbanization have been restricted (Miyagi Prefecture 2010). This seems to have naturally suppressed the increase of population in the coastal area. With the increase in population in Sendai City in recent years, housing sites were developed on the hilly land in the west part of the city at first. Reaching the limit of land capacity on the hillsides, however, areas around the main roads and railway stations in adjacent areas such as Natori City and Iwanuma City were developed as commuter zones. In Sendai City

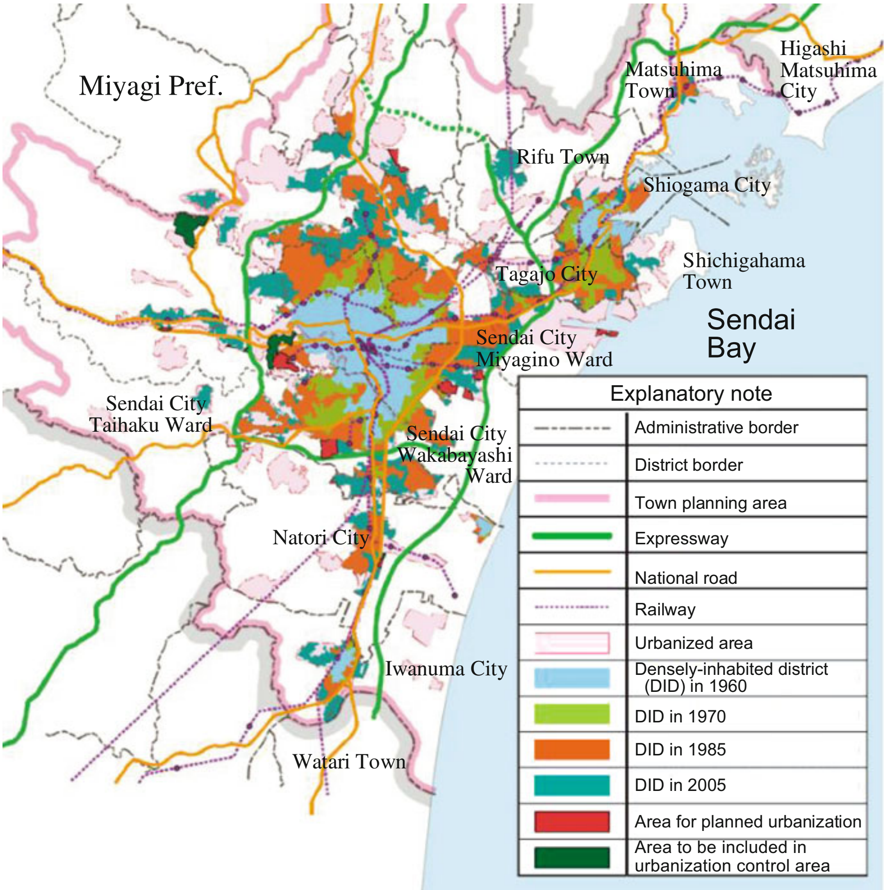

Fig. 18.6 Urbanization trends in central Sendai (From: Policies of Preparation, Development and Maintenance of Extensive Sen-en Area for Urban Plan, May 2010. http://www.Pref.Miyagi.jp/uploaded/attachment/216383.pdf)

as well, some areas in the eastern areas of the city such as Nagamachi had started to be developed (Fig. 18.6).

In the coastal areas, too, new urban and residential areas had been developed on a comparatively large scale remaining as urbanization control areas in and around Arahama, Sendai City, and also houses were distributed in agricultural communities, though in low density. Residential areas developed with a fishing port as a center in Yuriage, Natori City, and Sendai Shiogama port area which had been industrialized and populated were hit by the disaster (Fig. 18.7).

On the other hand, Ishinomaki City, located north of Sendai Bay, has its central area near the coastal zone, and it suffered the greatest damage among GEJE-afflicted districts. Yamamoto town located on the south side of Sendai Bay has a small area

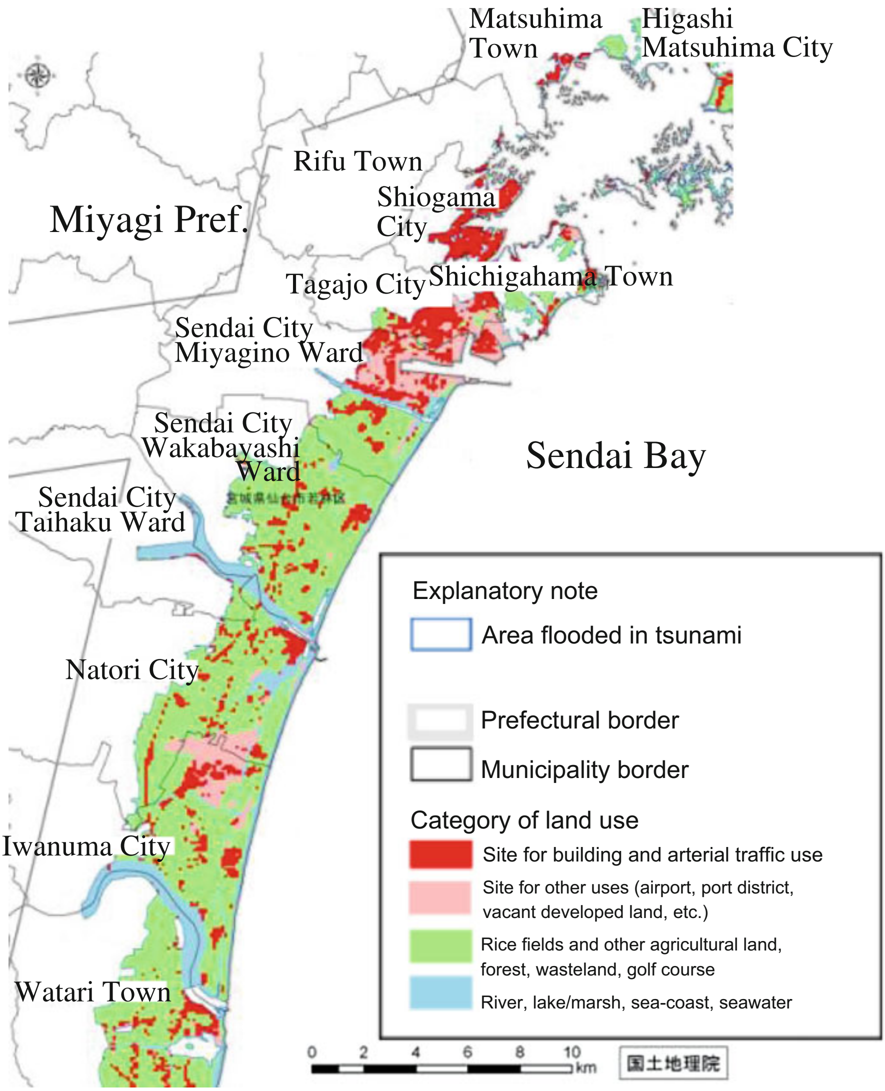

Fig. 18.7 The use of flood zone land in central Sendai (From: Geospatial Information Authority of Japan/GSI. http://www.gsi.go.jp/common/000060269.pdf)

of flatland, though it is located in Sendai plain; here residential districts and farmland existed in a mixed fashion, and the damage was severe.

As the inundation by tsunami after the GEJE was blocked by a raised road in east Sendai, the construction of a secondary levee by raising a road has been considered. As the estimated depth of inundation is smaller inside the levee, in many cases the area on the seaward side of the secondary levee is designated as disaster hazard area. Residency there is restricted and relocation to inland has been promoted. Inland of the levee is either not designated, or if designated, it is with a relaxation provision to allow houses to be constructed if the land or the floor height is raised (Fig. 18.4).

18.3.2 The Situation of Sanriku Coastal Regions

In contrast with the Sendai Bay coastal areas which are under the influence of urbanization from Sendai City, people in the Sanriku coastal regions have fostered a close relationship with the ocean. With its rich fishing grounds, the regions have long been involved in fisheries and marine products processing industries including inshore, offshore, and high seas fisheries, as well as aquaculture industry.

On the other hand, the Sanriku coastal regions have been stricken by tsunami many times in the past. In some districts people relocated to higher ground after the 1896 Meiji Sanriku tsunami, the 1933 Showa Sanriku tsunami, and the 1960 Chilean tsunami as mentioned above. Some people still live in the relocated place, but some others built a house on the lower ground some years after the disaster. The reasons for this include that some needed an extra housing lot when the household was divided, there was not enough land for housing in the first place, and some people had to relocate their community to the seaside again due to an outbreak of wildfire near the relocation district. In the case of the GEJE, some places they had relocated to as well as their original places were inundated. It should be noted that there were many cases where evacuation from the tsunami went well as a result of active disaster prevention education at school and drills in the neighborhood in tsunami-prone areas. On the other hand, some residents who stayed home because it had not been flooded by tsunami in the past became victims.

Response to tsunami after the GEJE has mainly consisted of the construction of tsunami breakwaters, ground raising, and relocation of housing to higher land. The heights of the breakwaters are generally bigger than the one on the coast of Sendai Bay, and some are much higher than 10 m. It is not quite possible to construct a secondary levee as the flatland is narrow along the shore. As a result, in some districts where the estimated inundation area in an L2 tsunami is large, especially in the coastal region in north Miyagi Prefecture, the ratio of designated area to the flooded area is around 70 % (Fig. 18.5).

We observed in this section the situation before the GEJE and the distinctive response to the tsunami after the disaster in coastal regions in Sendai City and Sanriku. It can be said that there are comparatively fewer gaps between the use of land and building restrictions in the Sendai Bay coastal area. In the coastal regions in Sanriku, in contrast, while the fishery developed because of the land formation, the landform is prone to tsunami damage. It is hard to make good use of the topographical advantage when the land use is regulated by the tsunami inundation simulation alone.

18.4 Cases of Disaster Hazard Areas

It is not easy to take both safety and reconstruction of life and community into consideration in the short period following a disaster. In many cases in the GEJE-afflicted areas, housing relocation projects proceeded first, and then the use of the original land was planned. In this section, we are examining the local characteristics through the actual examples of reconstruction in relocation sites and on the original sites to see the importance of flexibility in considering methods of reconstruction. We present the cases in Higashimatsushima City located on Sendai Bay coastal area and in Kesennuma City located in the Sanriku coastal area.

18.4.1 Higashimatsushima City: Step-by-Step Tsunami Disaster Prevention and Guide to Residence Relocation

Higashimatsushima City is located facing Ishinomaki Bay, which is the north end of roughly three divisions of the greater Sendai Bay. The city has an area of 10,136 ha, of which the habitable area is 7203 ha (the percentage of the habitable land is 70.7 %). Delta and coastal lowlands at a height of 5 m or less gently reach inland. About one-third of the city area of 10,136 ha, or about 3700 ha, was inundated by the tsunami. While the central district escaped huge damage, many houses especially in the eastern and western portions of the coastal area suffered damage. The area of 1202 ha or 32.5 % of the flooded area have been designated as a disaster hazard area. In Higashimatsushima City, relocation from the flooded area has been promoted in stages, and projects to prevent tsunami from incursion have been carried out. Also ways to actively utilize the original sites after relocation have been sought.

18.4.1.1 Tsunami Disaster Prevention with Secondary and Tertiary Levees and Building Restrictions According to Estimated Depth of Inundation

As mentioned before, the even shape continues in Higashimatsushima, allowing tsunami to travel inland unless stopped somewhere. Therefore a three-step method to prevent tsunami has been considered. The first step is a tide embankment of +7.2 m above T. P. (Tokyo Peil) along the coast constructed by Miyagi Prefecture against L1 tsunami; the second is multifunctional disaster prevention forests with the height of T.P. +6.2 m on hills artificially constructed with surplus soil from reconstruction projects. The third step of the plan is to raise a city road which runs through the city to T.P. +3.5 ~ +4.5 to make it function as a levee to protect the central city area.

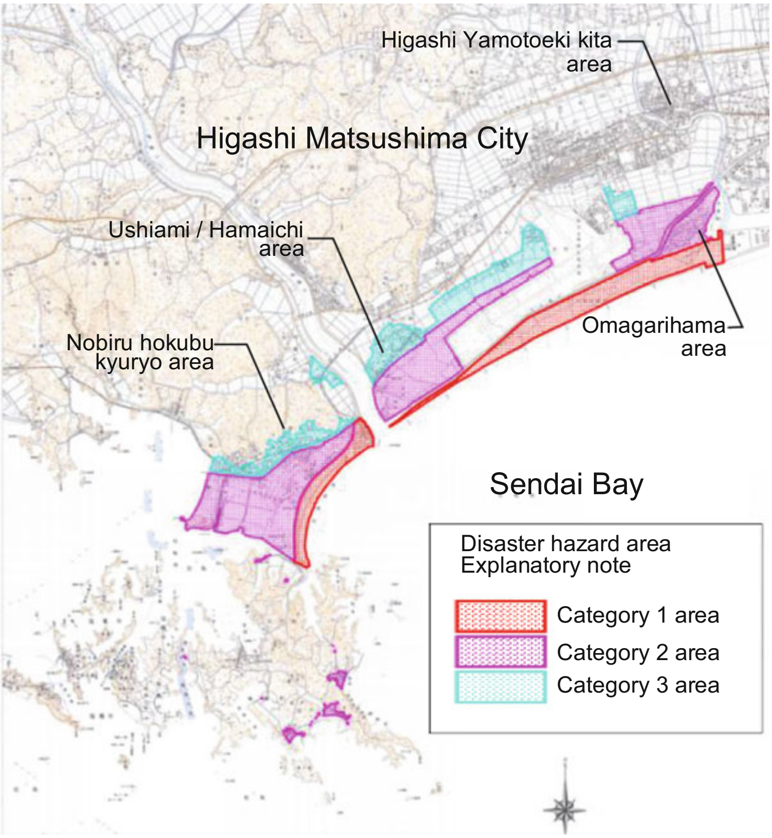

Fig. 18.8 Tsunami disaster prevention area in Higashimatsushima (http://www.city.higashimatsushima.miyagi.jp/kakuka/fukkou/toshi/tunami_area.html)

Disaster hazard areas are designated in three categories following the tsunami disaster prevention plan (Fig. 18.8). The target of building restrictions in the disaster hazard areas set by Higashimatsushima City is housing and facilities for medical or child welfare use. In the category 1 areas, these buildings are completely prohibited; in the category 2 areas, some buildings prohibited in the category 1 area are allowed to be constructed if stipulated conditions such as that the main structural part has to be a reinforced concrete structure are met; and in the category 3 areas, these buildings are allowed to be built if stipulated conditions such as that the bottom of the building up to 1 m high from the surface of the connecting road has to be a reinforced concrete structure are met. These regulations are relaxed based on the report by the national government which says that the percentage of total collapse increases when the inundation height exceeds 2 m in Japan where many houses are wooden. Behind this relaxation by Higashimatsushima lies the fact that after the GEJE, in the cases where a house was inundated but not washed away, the residents repaired the house and lived there.

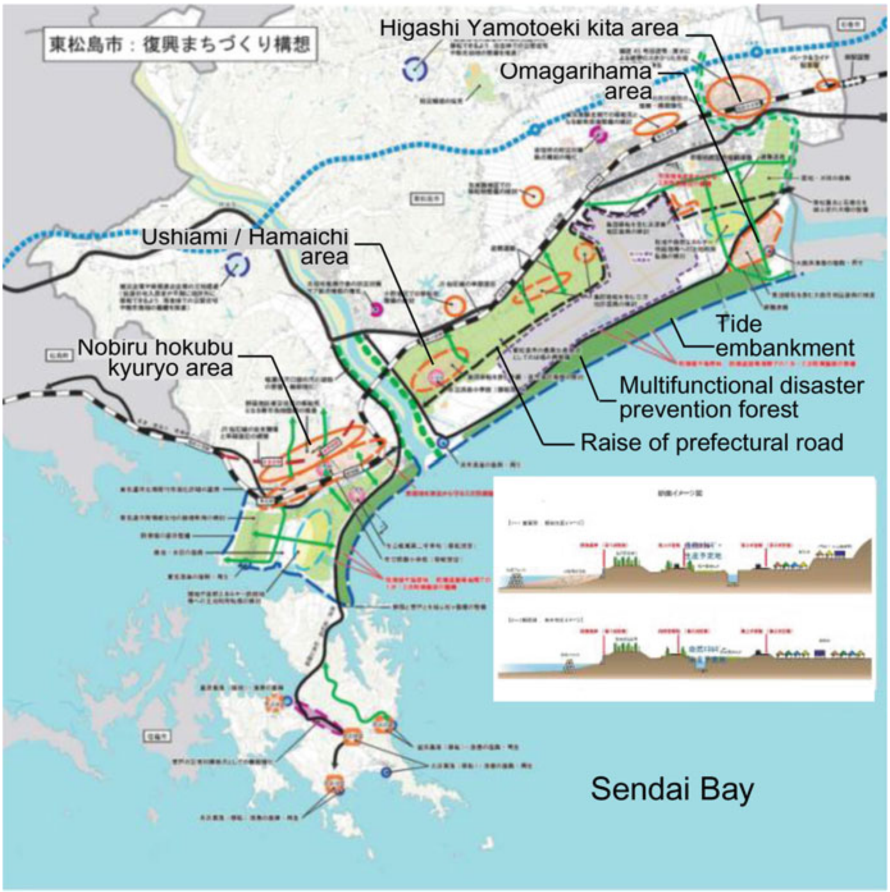

Fig. 18.9 Reconstruction town development design in Higashimatsushima (http://www.city.higashimatsushima.miyagi.jp/kakuka/fukkou/fukkou/jyoho.html)

18.4.1.2 Process of Attractive Relocation Projects

In Higashimatsushima, relocation of housing from coastal areas to inland has been promoted, while the depth and area of inundation are controlled with secondary and tertiary levees (Fig. 18.9). There are seven relocation housing estates planned by Higashimatsushima's disaster prevention promoting group relocation projects. Higashi yamotoeki kita estate, one of the seven, has been prepared by readjusting farmland and its surrounding area. It is located next to an existing urban district and provides over 270 housing lots and also public housing for disaster victims. It means the convenience is assured as existing shops and facilities are within walking distance from the relocation site.

Also it is common here for residents to play a central role in discussions about zoning and living arrangements. Higashimatsushima was created in the merger of the towns of Yamoto and Naruse in 2005. At that time, with the area of the city having expanded, the city of Higashimatsushima judged that the city government alone is not able to maintain services for residents and began to promote the autonomy of residents, for instance, leaving the management of the city center to residents' groups. This promoted resident's autonomy brought careful consideration among residents and municipality from the preparatory period of relocation. Residents often had gotten together to discuss housing issues and the municipal officers had reconsidered raised issues at municipal staff meetings and found solutions. This works well not only to improve the physical amenities and convenience at the relocation site but also for the people unfamiliar with each other to create a new community and grow attached to the district.

Also in the case of newly developed hill sites like Nobiru Hokubu Kyuryo estate, many measures have been taken such as construction of a station nearby and securing lots for merchants to open shops to improve convenience for the residents.

18.4.1.3 Land Use in Cooperation with the Private Sector

The ratio of disaster hazard area to flooded area in Higashimatsushima is 32.5 %, not so high compared with the other municipalities in the Sanriku coastal region, but still presenting a huge challenge about what to do with the remaining land in relation to maintenance and management of the land and creation of jobs (City Bureau et al.2013). In the city, they have been working on the flooded lands dividing them into three patterns of land use: conversion, mixed use, and restoration. In Higashimatsushima, they also have established Higashimatsushima Organization for Progress and Economy, Education, Energy (HOPE), a general incorporated association, to aggressively introduce corporate support.

In Omagarihama, an eastern area of the city, land readjustment is being carried out to convert the land from residential use to commercial use. A preferential treatment system has been prepared to attract companies to the converted land which offers reduction and exemption of rent and partial subsidy for the initial investment amount for the case which meets the conditions stipulated by the city. Here, there have been some adjustments between the Reconstruction Policy Division, Reconstruction Policy Department which is in charge of planning land use, and the Commerce and Industry Section, Commerce, Industry, and Tourism Division and Industry Department, which had been working at attracting factories since before the earthquake. Also the experiences from the construction of Greentown Yamoto (Yamoto Industrial Estate) and Okumatsushima Hibiki Industrial Estate that started before the disaster and attraction of corporations for the sites have been being applied. Fourteen companies concluded arrangements for two-thirds of the publicly offered lots in the Omagarihama industrial site as of April 2015.

In Ushiami and Hamaichi, western areas of the city, on the other hand, on top of the fact that residential zones and farmland were mixed, the land and lots the municipality bought were dispersed in a patchy fashion. The city has assembled the land and lots together, replaced topsoil on the originally residential lands, and leased it to private organizations such as agricultural production corporations to promote the use of land and industries.

In this section we focused on the work in the lowlands by the city of Higashimatsushima. The city did not have comprehensive plans for land use at the stage of designating disaster hazard areas. The municipality, however, began to have the residents get involved through the planning process where the disaster hazard areas were categorized into three groups based on the step-by-step tsunami disaster prevention in order to give the residents wider choices and make the relocation sites more convenient and comfortable for the people to live. There are some issues that want more examination such as support for residents who decided to reconstruct their houses on the original sites in the disaster hazard area and the effect of dividing the disaster hazard areas in three levels. It can be said, however, the methods are well thought out to allow the residents to be involved from the planning phase in order to make it possible for them to have sustainable, comfortable residences and to actively develop farmland with private sector organizations regarding the land use of the original sites after relocation.

18.4.2 Kesennuma City: Disaster Prevention Measures Centering on Purpose of Land Use

Kesennuma City, located in the Sanriku coastal region, is the northernmost municipality in Miyagi Prefecture and has a border with Iwate Prefecture. City areas and communities have developed with many bays of various sizes on the rias coastline. The region developed with fishing and fish processing industries and the reconstruction of these industries are considered to be essential for the restoration of Kesennuma City. In the city area of 33,338 ha, the habitable land is 9290 ha (27.9 %), and about 1800 ha was flooded in the tsunami. The portion of the area designated as a disaster hazard area was 77.2 % or 1390 ha. It was, however, hard to secure relocation sites for all the disaster-stricken residential districts because the districts that suffered inundation were scattered in every bay area and the city has more hilly lands and relatively less plain. The city of Kesennuma, therefore, adopted a security method which takes the possibility of reconstruction on the original sites as well as relocation and the effect of evacuation action as well as tsunami prevention into consideration based on the safety policy to protect people even if a tsunami hits while they are asleep at night. A council was also set up to discuss the restoration of the central city area and to seek the possibility of rebuilding on the original sites.

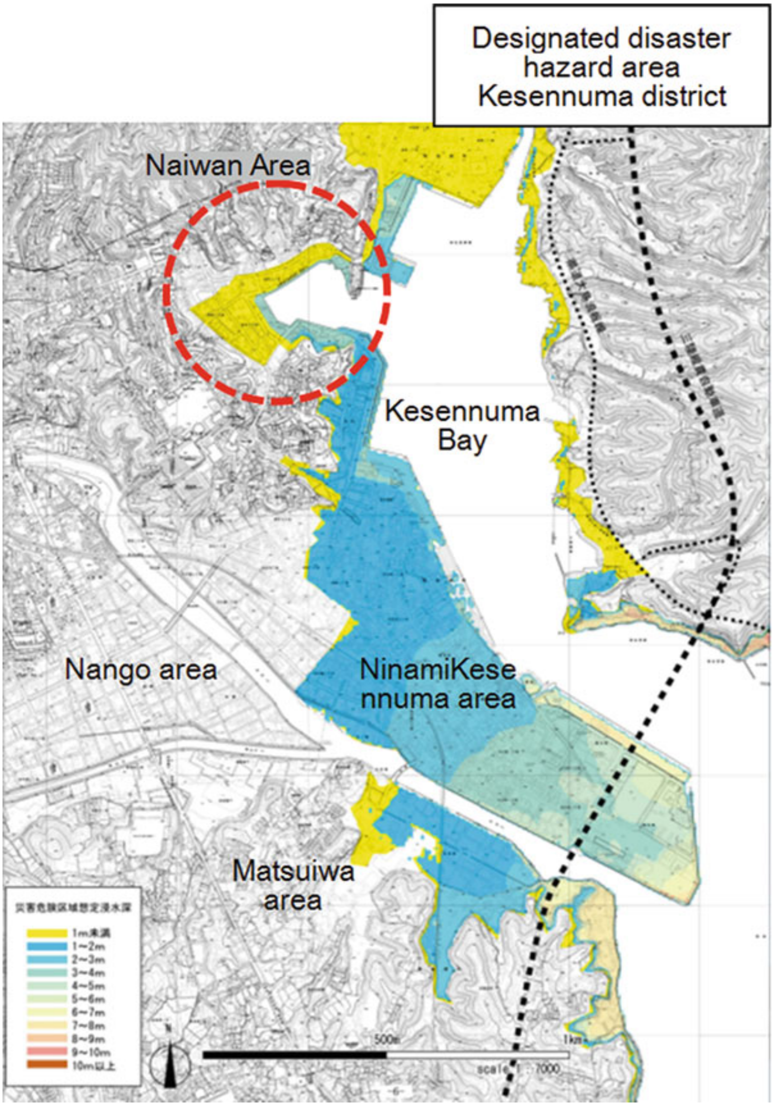

Fig. 18.10 Map of the designated disaster hazard area in Kesennuma district (http://www.city.kesennuma.lg.jp/www/contents/1408322300473/files/kikenkuikimap-kesennuma-naiwan.pdf)

18.4.2.1 Regulation and Tsunami Escape Building Response to Estimated Inundation Height

Kesennuma City, too, designated disaster hazard areas based on inundation simulation like the other municipalities. One of the characteristics different from the others is that the disaster hazard areas are categorized into 11 divisions with each meter of the estimated inundation height (Fig. 18.10). Kesennuma City has been approving rebuilding on the original site when the safety of the living space is secured or evacuation space is ensured against the estimated inundation height.

In Kesennuma City, buildings targeted by regulations in the disaster hazard areas are roughly classified into three categories: (1) houses, hotels and Japanese inns, training center dormitories, and so forth; (2) facilities for medical or child welfare use and so forth; and (3) buildings of wooden structure. When residents construct a building within a disaster hazard area, living space in every building has to be above the standard water level. Also in the case of (2), either an evacuation space within the building or an evacuation route above the standard water level connected to an evacuation place on higher ground is required. In the case of (3), though construction of a wooden structure is not allowed in the area with the estimated inundation depth of 2 m or more, it also means that non-wooden structures such as reinforced concrete structures which meet the regulation can be built.

In these regulations, the idea of a tsunami escape building is taken into consideration. In the GEJE many people actually evacuated to the upper floors, and the standard of a tsunami escape building has been reviewed by the national government after the disaster.

Behind the fact that Kesennuma approves construction even in a disaster hazard area when the conditions are met, there lies a fact that some residents wish to reconstruct their houses on the original sites. And also it was necessary to secure the evacuation space for people who work there because construction of commercial or industrial facilities was allowed in a disaster hazard area. One of the purposes Kesennuma had was to secure buildings which can function as tsunami escape buildings. In Kesennuma City, the Risk Management Department and Industry Department as well as the Construction Department that is in charge joined the discussion on the method of disaster hazard area designation at the investigation stage. It can be said that this allowed the situation and challenges in the reconstruction to be examined from various viewpoints in the process of formation of a disaster hazard area designation method (Araki and Hokugo 2015).

18.4.2.2 Reconstruction of the Central City Area

A local group in Naiwan area (the inner bay area), which is the old central area of Kesennuma City, Miyagi, has been focusing on reconstruction on the original sites even after suffering damage in the tsunami caused by the GEJE. Also the residents do not recognize the necessity of a tide embankment which is greatly influential on the inundation estimate, and discussion has been taking place with the administration (Fig. 18.10).

One of the reasons was that Naiwan area has hills behind it and residents believe they can secure their lives by evacuating. The other reasons they were against the embankment included the fact that they have close ties with fishery, the convenience and scenery would be spoiled by the embankment, and the prolonged construction work would accelerate the outflow of merchants and residents. In response,

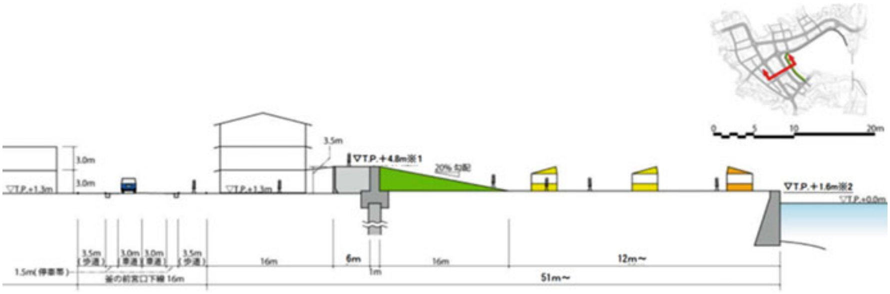

Fig. 18.11 Proposal of tide embankment in Minamimachi, Naiwan area in Kesennuma City

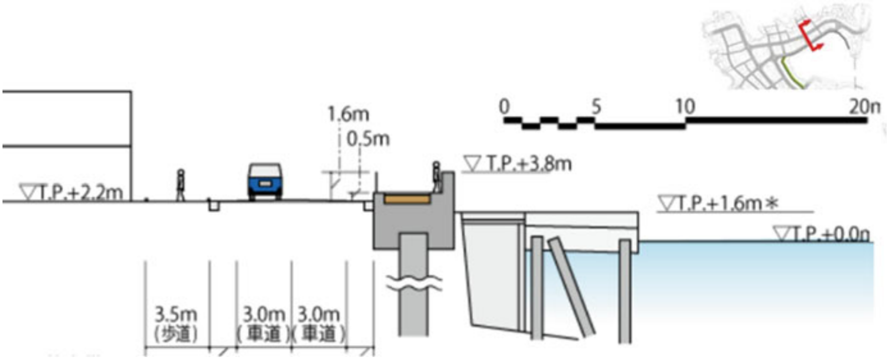

Fig. 18.12 Proposal of tide embankment in Sakanamachi, Naiwan area, Kesennuma City, regarding the request about tide embankment in inner bay area, Kesennuma City (based on recommendation from inner bay area town development council) December 5, 2013

Kesennuma held an idea competition with representatives of residents and intellectuals as a jury in 2012. What was wanted in the competition was an idea of community creation together with a guideline for security against tsunami in its project scheme (Araki and Hokugo 2013).

The first prize was after all given to an idea of a floating tide embankment set in the sea. Miyagi prefectural government who is in charge of its management, however, did not approve the idea, and a tide embankment on shore was put under discussion among the prefectural and city governments and residents at a town development council established by the city's initiative. In Naiwan area, some districts have a comparatively wide area of plain, but other districts have only a strip of flatland. In the latter case, usable land would disappear if an embankment with a wide foundation were built. In the end it was decided that an upright tide embankment should be constructed in the districts where the land is not wide, and then a 1-m high movable levee is placed on top. Then the ground inland of the embankment should be raised by 2.8 m, reducing the apparent height from inside down to 1.3 m. Though it was unsatisfactory for the residents who did not recognize the necessity for an embankment, they decided to accept the suggestion as the number of people who would wish to reconstruct their lives in the districts would further decrease if the discussion were further prolonged. As a result, the ground in the district was raised for zone readjustment, the estimated inundation depth was reduced to less than 1 m though designated as disaster hazard area, and then usual buildings were approved to be built with a raised floor height (Figs. 18.11 and 18.12).

We examined the approach for disaster prevention from the land use point of view taken in Kesennuma City in this section. There remain many issues such as the location and height of the embankments and usage of the original sites after relocation. Also it does not mean that such an approach that takes care of characteristics of each individual district seen in Naiwan area can be seen in all the districts. It can still be said, however, that the process in which they contemplated a future vision for the region and tried to think of the way to realize it as a method of securing safety and the framework where residents, administration, experts, and engineers joined in a series of discussions are a notable approach for considering both post-disaster safety and community restoration at the same time.

18.5 Conclusion

In this chapter, we scrutinized the measures and actions against tsunami after the GEJE through the designating process of disaster hazard areas, the relationship between the use and the shape of the land, and the actual example cases of countermeasures against tsunami in two cities in the afflicted area.

In the first section, we overview the damage caused by the GEJE and the government's policies to deal with tsunami and point out issues regarding land use management in the period after the GEJE. Then in the second section, the fact that the larger the area of inundation in the region is, the slower the reconstruction work proceeds is presented from an analysis of the method and situation surrounding disaster hazard area designation. The pre-earthquake situation and the post-disaster policies to address tsunami in the afflicted areas are indicated in the third section. While the damage was reduced in the coastal plains in Sendai where development had been regulated, the Sanriku coastal region where reconstruction had been carried out repeatedly in the areas prone to inundation due to the need of using the coastal lands has suffered from disasters many times. It is indicated that disaster prevention policies depending on land use management alone can hinder the restoration of communities and people's lives. In the fourth section, taking actual approaches toward reconstruction in a couple of disaster-stricken cities as examples, we discussed the importance of appropriate safety guidance according to the risk, the construction of community with an environment well developed with resident participation in the relocated site for their permanent residence, and the effort to work out the use of the original land with various organizations. We also discussed the importance of examining the security method with a focus on the purpose of land use when a house is reconstructed on its original site and of having the main persons of the reconstruction as the center of the discussion.

In this section, looking at examples in Japan, we discuss three topics which should be considered for land use management against tsunami in other nations and regions. First is the necessity of a comprehensive land use plan based on a reconstruction vision, next is the importance of the revision process as risk communication, and the last one is the bottom-up process of safety consideration as a perspective for the future through formation of a community disaster management plan.

18.5.1 Land Use Management Based on Reconstruction Vision

When a large-scale natural disaster occurs, what the neighborhood should look like becomes hard to visualize as the local scenery has disappeared and residents have dispersed. It is, therefore, necessary to provide a vision for the local reconstruction in order to form a consensus for the restoration. The post-GEJE reconstruction plans have been formed in each municipality, and reconstruction work has proceeded according to the plans. As mentioned in the first paragraph, Sect. 18.2, it is common across almost all the municipalities that the L2 tsunami's estimated inundation areas have been designated as disaster hazard areas based on the government-initiated two-stage tsunami prevention measure and the height of the embankment against L1 tsunami set by prefectural government. If what the neighborhood should be like is to be restored and the original local characteristics are taken advantage of, the use of land and the anti-disaster measures should be considered depending on the purpose, as seen in some cases in the Naiwan area, Kesennuma City. Then forcible regulations on land use should be applied only after the target and location have been closely examined and applied to the sites where it is totally impossible to secure the safety of human lives and to the locations which can be in great danger when flooded. We also believe that if the priority is placed on smooth reconstruction of local communities and people's lives, the situation should be handled not with regulations based on shortsighted judgment, but with the land use management taking the span of building restoration into account such as conversion of land usage and changes in town planning areas to encourage the realization of the local vision on a long-term basis.

18.5.2 Necessary Risk Communication as Reconstruction Process

Individuals and local communities have a myriad of issues in post-disaster reconstruction, let alone in times of peace. If the issues are taken as risks which hamper the restoration, discussions are essential among main players of reconstruction to find out which risks should be preferentially avoided or reduced, what the acceptable level might be, and which method should be taken to deal with the risk. There are many ways of avoiding or reducing risk, for instance, risk avoidance by relocation, risk reduction by evacuation with original site housing reconstruction accepting property risk or risk transfer by earthquake insurance. It is also conceivable to combine these to deal with the risk of tsunami.

A deeper exploration reveals that the method itself is a problem; the result of simulation alone is strictly adopted with no awareness of uncertainty of the very parameters such as the scale and direction of the tidal level and fault rupture and the destruction of embankments and other infrastructure. The impact of disaster management projects as well should be examined if under normal circumstances.

The combined risks should be investigated and confirmed, and the methods which are as close to the reconstruction vision and local vision as possible should be sought among the main parties and persons of the reconstruction, and new approaches should be given consideration; the process of the examination and dialogue itself can be an effective form to rebuild local relationships which have been lost in the disaster.

18.5.3 Bottom-Up Process of Safety Consideration Through Formation of Community Disaster Management Plan

Lastly we discuss the future prospects of how administration and local communities should be prepared for tsunami. In December 2011, after the GEJE, Tsunami Prevention Region Development Law was issued. This law was to promote "tsunami prevention region development" by "multiple prevention methods" combining hardware with software. It is the same as the post-GEJE reconstruction that the depth of inundation is estimated for choosing what measures should be taken, but a big difference is that the target areas have not actually been disaster-stricken and industrial buildings and houses exist and many people actually live there.

Prefectural governors are regarded to have authority to designate "tsunami disaster caution districts" as areas for especially elaborate warning and evacuation arrangements and "tsunami disaster special caution districts" as areas where certain development and construction should be restricted to protect lives and health in the estimated tsunami inundation areas. Tsunami disaster caution districts, however, have been designated in only two prefectures, and no tsunami disaster special caution districts have been designated though 22 out of 39 prefectures along the coast have designated some estimated tsunami inundation areas (as of May 22, 2015) (Website of MLIT 2015).

The situation is similar to that of the preceding case of Sediment Disaster Prevention Law in which the designation of sediment disaster hazard areas and sediment disaster special alert areas has not proceeded. One of the possible reasons is the protest from the landowners and leaseholders who are afraid of the decline in value of the land if it is identified to have risk factors.

On the other hand, by the amendment of the Basic Act on Disaster Control Measures in June 2013, it became possible for a community disaster management plan to be stipulated in a regional disaster management plan which had been formed at the prefectural or municipal level or for a community group to present a community disaster management plan (Cabinet Office 2014). This, in turn, made it possible for the administration to identify and take the individual neighborhood activities into account in the official plan. Though there are many issues such as verification method, guarantee of consistency, and reservation of budget for industrialization, now residents can propose plans that they thought of as well as the administration stipulating the security method for the district, and the local circumstances can be reflected more. Also to encourage residents to address the issue on an autonomous basis means to instill the attitude to think about measures taking disaster risk into consideration into the level of residents. It is expected that the local disaster management capability will be recognized and lead to an increase in local value even if it is in areas with disaster risk.

A risk assessment to objectively assess the risk in an area is important. However, even more important is to carry it out along with creating a system in which the local residents recognize and accept the risk then address the risk management spontaneously and continuously.

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Chapter 19
Land Use Change Implications on Ba Ria-Vung Tau Province in Vietnam

Tho Tran, Rajib Shaw, and Michiko Banba

Abstract Ba Ria-Vung Tau province is one of coastal areas in the southern of Vietnam with over 300 km coastline. The province is also one of the most socially and economically developing provinces. Its GDP per capita in 2010 was 5872 US$ (BRVT 2011). Thus, land use in this area has been changed quickly during the last decade. The land use statistic numbers of the province from 2005 to 2010 showed that there were large areas of agricultural land converted into nonagricultural land such as residential areas, industrial and cluster industrial zones, and infrastructure development. For example, from 2005 to 2010, rice land reduced 3014 ha (16.83 %), while land for nonagricultural production and business increased 5847 ha (97.74 %). For the future development in terms of land use management vision for the year 2020, in the local, provincial, and district levels, land use planning was issued by the central and local government within 2013 and 2014. And the same trend of land use change seems to be continued in the future. Unfortunately, these land use policies are not integrated with climate change issue for disaster risk reduction. This chapter will analyze the land use changed for development in the province from 2005 to 2010 and land use change focus for the period 2010–2020; the status of coastal erosion and potential areas will be affected by sea level rise.

Keywords Land use change • Coastal area • Development • Agricultural land • Vietnam

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19.1 Introduction

Ba Ria-Vung Tau province (BR-VT) is located on the southeastern coastal region of Vietnam from 10° 19′ 08″ to 10° 48′ 39″ north latitude and from 107° 00′01″ to 107° 34′ 18″ east longitude. It has a total area of 1989.5 km^2; it has eight administrative units including Vung Tau City and Ba Ria City and six districts, namely, Long Dien, Dat Do, Tan Thanh, Chau Duc, Xuyen Moc, and Con Dao Island with a total of 82 communes, wards, and towns. The province shares the border with Ho Chi Minh City, Dong Nai province, and Binh Thuan province in the west, north, and east, respectively (Fig. 19.1). From the south and the southeast is the coastline of 156 km. Vung Tau City used to be the province chief town, but the province's administrative center has moved to Ba Ria City since May 2012 (BRVT PC 2013b; Office 2013). In 2013, the province had 1,052,839 people; population density was 529 persons/km^2. The province is also one of the most socially and economically developed provinces. Its GDP per capita in 2013 was 13,217 US$ (Office 2013).

According to the master plan on socioeconomic development of BR-VT province in the 2006–2015 period toward 2020, development objectives are to build BR-VT into an industrial province. The province is planned to be strong in marine, economy with a system of national and international commercial ports, and industrial, service, tourist, and fisheries center of the region and of the country (Government 2007). Thus, land use in this area has been changed quickly during the

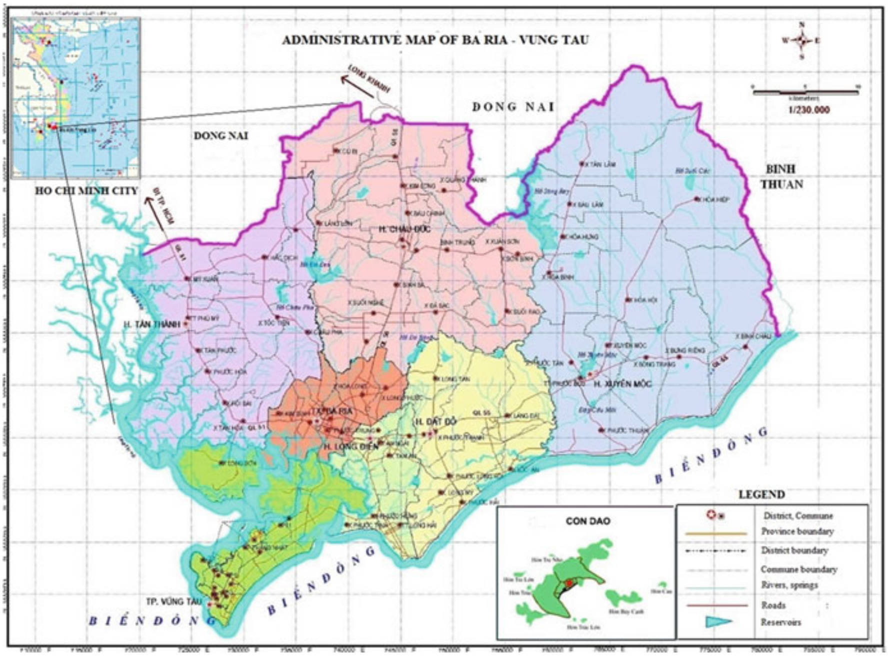


Fig. 19.1 Ba Ria-Vung Tau province administrative map

last decade. The land use statistic numbers of the province from 2005 to 2010 showed that there were large areas of agricultural land converted into nonagricultural land such as residential areas, industrial and cluster industrial zones, and infrastructure development.

For the future development in terms of land use management vision for the year 2020, in the local, provincial, and district levels, land use planning (LUP) was issued by the central and local government within 2013 and 2014. And the same trend of land use change (LUC) seems to be continued in the future. However, this LUP is not integrated with climate change (CC) issues for disaster risk reduction.

This chapter will analyze the gap between LUP policies and CC policies in implementation of mainstreaming CC issues into LUP. It also illustrates that the provincial LUC and LUP (except for Con Dao district) would focus on economic development rather than disaster risk reduction. This land planning is vulnerable to coastal erosion and will be affected by sea level rise. Finally, this chapter discusses about several challenges of integration of climate issues into LUP in BR-VT and generates some suggestions.

19.2 The Gap Between LUP and CC Legislations in Implementation of Mainstreaming CC Issues into LUP

By analyzing integration relationship between LUP and CC legislation systems the results show a gap in implementation of mainstreaming CC issues into LUP.

On the one hand, the study reviews LUP legislation systems to seek climate change factors. The reviewed legislations include the Land Law 2003, the Decree number 181/2004/ND-CP, the Circular number 30/2004/TT-BTNMT, the Decree number 69/2009/ND-CP, the Circular 19/2009/TT-BTNMT, the Land Law 2013, the Decree number 43/2014/ND-CP, and the Circular 29/2014/TT-BTNMT.

One another hand, the climate change legislation systems are reviewed to find that land use factors include the National Target Program to Respond to Climate Change No. 158/2008/QD-TTg (NTP-RCC), the National Climate Change Strategy No. 2139/QD-TTg (NCCS), the National Action plan on Climate change for period 2012–2020 No. 1474/QD-TTg, the law on Natural Disaster Prevention and Control in 2013, and the Law on Environment Protection in 2014.

Analysis results reveal that before 2009, when the NTP-RCC was issued, the high awareness of environmental protection was early appear in LUP policies such as the Land Law 2003 and the Decree 181/2004/ND-CP. However, these policies just focused on evaluating environmental impact processes rather than climate change impacts. The flow may have resulted from the lack of information of climate change. Therefore, although the Circular no. 30/2004/TT-BTNMT stipulated analyzing and assessing climate change impacts on land use, the evaluation climate change impact process has been ignored in most of LUP at local levels.

After the NTP-RCC took effect in 2009, the high consciousness of the Vietnam's government about climate change adaptation and the great risks of natural disaster-related climate change have clearly involved in significant regulations like the NCCS, the National Action Plan Response To Climate Change, the Law on Natural Disaster Prevention and Control, and so on. These policies stipulated that climate change effect must be integrated into sectors development and social-economic master plans and plans. Particularly, in the Land Law 2013, the new interpretation of LUP was redefined as an environmental protection and climate change adaption process.

Although the relationship of two registration systems is quite clear, there is a big challenge of integration of climate change issues into LUP at local levels. The main reason is lack of climate change impact analysis at local levels. For example, climate change and sea level rise scenarios are just available at the national and regional level. To show the problem, each province has been building an appropriate action plan to respond to climate change including climate change impact analysis. Moreover, local authors should take advantage of new regulation of the Land Law 2013 and the Circular number 29/2014/TT-BTNMT for finding a relevant relationship between land use and climate change issues at specific area. Finally, the relationship between climate change and LUMPP has been further clarified by the new laws and its implementations. However, integration of climate change into LUMPP at the local levels seems to be at the starting stage of the process.

19.3 Land Use Change in the Period of 2005–2010

According to the result of land inventory in 2010, the BR-VT province had a clear trend conversion of agricultural land into nonagricultural land during the period of 2005–2010. Agricultural land areas decreased by a total of 8327.68 ha. Within decreased lands, paddy land reduced the largest area with 3014.57 ha followed by perennial crop land with 2917.93 ha and protective forest with 1599.26 ha. The coverted land was used for three main land use purposes including (1) production and business land, (2) public land and (3) residential land. The first land use purpose has the largest area with 5847.62 ha of industrial land, business land, land for production facilities, land for mineral activities, and land for producing building materials and ceramics. The second land use purpose with 3422 ha was used for building infrastructure, education and sports, and landfill sites. The third land use purpose with 1920.5 ha was used for housing.

Table 19.1 shows that from 2005 to 2010, paddy land was reduced in most of the districts. For example, Chau Duc district had the largest reduced rice land at 1545 ha. Then Tan Thanh district lost 638.52 ha. Similarly, perennial crop land experienced the same reduction trend. In this case, Tan Thanh district had the biggest conversion area with 1140.65 ha, followed by Chau Duc and Dat Do districts with 899.41 ha and 859.9 ha, respectively. There was nearly a quarter of protective forest area with 1600 ha cut down in Tan Thanh district for ports and industrial projects.

Table 19.1 Location of land use changes between 2005 and 2010

Land types		Vung Tau	Ba Ria	Chau Duc	Xuyen Moc	Long Dien	Dat Do	Tan Thanh	Con Dao	Total
Paddy land	2005	256.24	1863.22	4389.14	2319.22	1534.75	5936.40	1540.33	75.13	17,914.43
	2010	218.84	1731.56	2843.74	1841.05	1387.80	5908.47	901.81	66.59	14,899.86
	Change	−37.40	−131.66	−1545.40	−478.17	−146.95	−27.93	−638.52	−8.54	−3014.57
	Percentage	**−14.60** %	**−7.07** %	**−35.21** %	**−20.62** %	**−9.57** %	**−0.47** %	**−41.45** %	**−11.37** %	**−16.83** %
Perennial land	2005	1689.55	1970.95	26,641.52	28,915.10	978.91	5297.92	11,593.68	38.27	77,125.90
	2010	1455.62	1945.71	25,742.11	29,100.80	1028.78	4438.02	10,453.03	43.90	74,207.97
	Change	−233.93	−25.24	−899.41	185.70	49.87	−859.90	−1140.65	5.63	−2917.93
	Percentage	**−13.85** %	**−1.28** %	**−3.38** %	**0.64** %	**5.09** %	**−16.23** %	**−9.84** %	**14.71** %	**−3.78** %
Protective land	2005	1908.42	303.49	464.08	895.82	666.51	1372.84	6687.60	456.66	12,755.42
	2010	1803.56	303.49	503.72	895.82	817.19	1412.35	5105.17	314.86	11,156.16
	Change	−104.86	0.00	39.64	0.00	150.68	39.51	−1582.43	−141.80	−1599.26
	Percentage	**−5.49** %	**0.00** %	**8.54** %	**0.00** %	**22.61** %	**2.88** %	**−23.66** %	**−31.05** %	**−12.54** %
Business land	2005	1332.38	354.56	89.29	491.74	157.92	314.56	3190.15	52.94	5983.28
	2010	1429.72	363.45	2065.45	824.31	301.35	484.59	6267.07	95.22	11,831.16
	Change	97.34	8.89	1976.16	332.57	143.43	170.03	3076.92	42.54	5847.88
	Percentage	**7.31** %	**2.51** %	**2213.19** %	**67.63** %	**90.82** %	**54.05** %	**96.45** %	**79.86** %	**97.74** %
Public land	2005	1048.74	771.08	1445.09	2013.14	612.97	760.86	1491.84	169.14	8312.86
	2010	1159.23	853.41	3240.86	1985.20	637.00	1020.75	2558.06	280.36	11,734.87
	Change	110.49	82.33	1795.77	−27.94	24.03	259.89	1066.22	111.22	3422.01
	Percentage	**10.54** %	**10.68** %	**124.27** %	**-1.39** %	**3.92** %	**34.16** %	**71.47** %	**65.76** %	**41.17** %

(continued)

Table 19.1 (continued)

Land types		Vung Tau	Ba Ria	Chau Duc	Xuyen Moc	Long Dien	Dat Do	Tan Thanh	Con Dao	Total
Rural land	2005	66.69	106.18	668.55	657.39	324.77	364.15	463.91	18.25	2669.89
	2010	72.82	194.03	844.65	750.1	359.19	178.2	543.71	23.34	2966.04
	Change	6.13	87.85	176.10	92.71	34.42	−185.95	79.80	5.09	296.15
	Percentage	**9.19** %	**82.74** %	**26.34** %	**14.10** %	**10.60** %	**−51.06** %	**17.20** %	**27.89** %	**11.09** %
Urban land	2005	875.16	647.58	91.18	86.22	220.41	0.00	128.46		2049.01
	2010	1172.21	647.82	87.04	88.46	226.35	213.39	238.12		2673.39
	Change	297.05	0.24	−4.14	2.24	5.94	213.39	109.66		624.38
	Percentage	**33.94** %	**0.04** %	**−4.54** %	**2.60** %	**2.69** %	**100.00** %	**85.37** %		**30.47** %

Source: BRVT PC 2010

However, in Long Dien, Dat Do, and Chau Duc districts, protective forests were reforested and afforested with total of 230 ha.

The main reasons for LUC are rapid industrialization, urbanization, and population growth. Therefore, agricultural lands were converted mostly into nonagricultural land for production, business, industrial zones, and residential areas. For instance, during 2005–2010 some industrial zones were established and widened such as Phu My I (959.38 ha), My Xuan A (302.4 ha), My Xuan A2 (422.22 ha), My Xuan B1 (227.14 ha), Cai Mep (670 ha), and Dai Duong (145.7 ha) in Tan Thanh district. Besides, new residential areas with 213 ha were established in Dat Do town and Phuoc Hai town in Dat Do district.

19.4 Land Use Planning in the Period 2010–2020

The provincial land use planning (LUP) for the period 2010–2020 was approved by the Vietnamese government through Resolution No. 81/NQ-CP dated June 27, 2013. The LUP involves zoning of the various land use types and planning for land conversion by the year 2020. The provincial LUP is based on the master plan of social-economic development, the national LUP, and social-economic conditions of the province. According to the provincial LUP, there will be nearly 30,000 ha of agricultural land transformed into nonagricultural land for developing infrastructure, industrial zones and clusters, and house building in both rural and urban areas. Table 19.2 illustrates the detail of future land use focus change at district level. More specifically, about 23 % perennial crop land will decrease in all districts by 2020 with the largest area of 17,425 ha including 5742 ha in Tan Thanh district, 3667 ha in Xuyen Moc district, 3379 ha in Chau Duc district, and 2122 ha in Dat Do district. Then, 13.3 % of paddy land will continue to decrease with a total of 1982 ha by 2020. The reduction of rice land will happen in most of other districts except Chau Duc district. For example, Vung Tau City will not have paddy land by 2020. Protective forest areas will reduce over 2500 ha in most districts. The main decreasing area is in Vung Tau City with 1117 ha.

According to the master social-economic development planning of BR-VT to 2020, conversion of land will be used for industrial zones and urban development mainly in Tan Thanh district. In addition, according to the Decision number 1113/QD-TTg dated 09/7/2013 of Prime Minister, a part of Tan Thanh district will be developed into a new city, namely, Phu My town by the year 2030. Therefore, by 2020 Tan Thanh district has the large proportion of LUC. Land use for industrial, residential, and transport will increase 206 ha, 467 ha, and 906 ha, respectively. LUC's focus on housing in urban and building transportation construction will also expand in most districts. For example, area of land for homestead will rise 492 ha in Vung Tau City, 178 ha in Ba Ria City, 115 ha in Chau Duc district, and around 65.5 ha in Xuyen Moc and Long Dien district.

Table 19.2 Land use change focus between 2010 and 2020

Land code		Vung Tau	Ba Ria	Chau Duc	Xuyen Moc	Long Dien	Dat Do	Tan Thanh	Con Dao	Total
Paddy land	2010	218.84	1731.56	2843.74	1841.05	1387.80	5908.47	901.81	66.59	14,899.86
	2020	0.00	964.00	2929.00	1735.00	1327.00	5334.00	579.00	50.00	12,918.00
	Change	−218.84	−767.56	85.26	−106.05	−60.80	−574.47	−322.81	−16.59	−1981.86
	Percentage	−100 %	−44 %	3 %	−6 %	−4 %	−10 %	−36 %	−25 %	−13 %
Perennial land	2010	1455.62	1945.71	25,742.11	29,100.80	1028.78	4438.02	10,453.03	43.90	74,207.97
	2020	346.00	1225.00	22,363.00	25,434.00	371.00	2316.00	4711.00	17.00	56,783.00
	Change	−1109.62	−720.71	−3379.11	−3666.80	−657.78	−2122.02	−5742.03	−26.90	−17,425.00
	Percentage	−76 %	−37 %	−13 %	−13 %	−64 %	−48 %	−55 %	−61 %	−23 %
Protective land	2010	1803.56	303.49	503.72	895.82	817.19	1412.35	5105.17	314.86	11,156.16
	2020	686.00	250.00	504.00	573.00	713.00	1198.00	4641.00	63.00	8628.00
	Change	−1117.56	−53.49	0.28	−322.82	−104.19	−214.35	−464.17	−251.86	−2528.16
	%	−62 %	−18 %	0 %	−36 %	−13 %	−15 %	−9 %	−80 %	−23 %
Industrial land	2010	1010.90	0.00	1550.20	0.00	0.00	496.20	5344.20	0.00	8401.50
	2020	1050.90	100.00	2655.20	30.00	43.00	546.20	5550.20	20.00	9995.50
	Change	40.00	100.00	1105.00	30.00	43.00	50.00	206.00	20.00	1594.00
	Percentage	4 %	100 %	71 %	100 %	100 %	10 %	4 %	100 %	19 %
Urban homestead land	2010	1172.21	647.82	87.04	88.46	226.35	213.39	238.12		2673.39
	2020	1665.00	826.00	202.00	154.00	292.00	235.00	705.00		4079.00
	Change	492.79	178.18	114.96	65.54	65.65	21.61	466.88		1405.61
	Percentage	42 %	28 %	132 %	74 %	29 %	10 %	196 %		53 %
Transport land	2010	827.00	593.00	1353.00	1656.00	423.00	708.00	2156.00	212.00	7928.00
	2020	1655.00	675.00	1479.00	2171.00	726.00	894.00	3062.00	324.00	10,986.00
	Change	828.00	82.00	126.00	515.00	303.00	186.00	906.00	112.00	3058.00
	Percentage	100 %	14 %	9 %	31 %	72 %	26 %	42 %	53 %	39 %

Unit (ha)

19.5 Climate-Related Impacts

19.5.1 Typhoon

In the last two decades, BR-VT province has been affected by some kinds of climate hazards such as typhoon, beach erosion, and drought. For example, the province was significantly damaged by the storm No. 5 (Linda) in November 1997 and the storm No. 9 (Durian) in December 2006. There were over 230 casualties and missing, and over 70,000 houses were collapsed and damaged. The total economic loss was a huge amount of money with 4200 billion VND (CFFSC 1997, 2006). Vung Tau City was the most seriously damaged area. Moreover, the current observations reveal that typhoon in the East Sea tends to occur later than before and move Southward of Vietnam. Therefore, BR-VT province has a long coastline with 48 km in Vung Tau City, 32 km in Xuyen Moc district, and 18 km in Long Dien district. These areas are likely to be more vulnerable to typhoons in the future.

19.5.2 Coastal Erosion

The province has been seriously impacted by beach erosion in most coastal districts. The areas with the most serious erosion are Trai Nhai (ward 12, Vung Tau City), Phuoc Tinh (Long Dien district), Binh Chau, Ho Tram, and Ho Coc (Xuyen Moc district). Figures 19.2 and 19.3 illustrate that the coastline in Trai Nhai, Vung Tau City,

Fig. 19.2 Coastline in Trai Nhai-Vung Tau 2008 (Source: Google Earth)

Fig. 19.3 Coastline in Trai Nhai-Vung Tau 2014 (Source: Google Earth)

Fig. 19.4 A house collapsed due to beach erosion

has been eroded significantly between 2008 and 2014. An area of land around 145,893 m^2 with the length of 1726 m and the width at the largest of 125 m and the narrowest of 23 m disappeared. Figures 19.4 and 19.5 show a house in this area was collapsed and sand dune was swept into the sea due to coastal erosion.

To respond to the problem, there had been some building projects to reduce the effects of beach erosion. For example, constructions applying Stabiplage technology

Fig. 19.5 Sand dune was swept away by seawater

Fig. 19.6 A Stabiplage construction in Loc An, Long Dien district (Source: Department of Technology and Science)

were built in Loc An in 2005 (Fig. 19.6). A storm shelter for fishing vessels was built in Ben Loi, Binh Chau, Xuyen Moc districts in 2009 (Fig. 19.7) and some other infrastructure constructions along the coastline in Long Dien and Xuyen Moc districts, where the impact is directly to local residential areas and tourism industry.

Fig. 19.7 A storm shelter construction in Ben Loi, Binh Chau, Xuyen Moc district (Source: Google earth in 2012)

19.5.3 Drought

Ba Ria, Vung Tau province, is close to the most drought-affected areas in Vietnam—the South Central and the Central Highland—where the Dinh, Ray, and Đu đủ rivers, the main water source of BR-VT, are derived from. In addition, BR-VT has a low precipitation level with a short rainy season. Recently, drought events have happened partly in BR-VT. As a result, agricultural productivity is reduced and the products' price also declined. For instance, some areas of annual crop and paddy were significantly affected by drought in Long Dien, Dat Do, Xuyen Moc and Chau Duc districts (BRVT 2014). To deal with water shortage, famers in Chau Duc and Xuyen Moc districts have to dig wells to exploit groundwater. Consequently, groundwater level may be reduced and polluted. Drought can lead to the risk of saline intrusion. However, salt famers can benefit from drought. According to a report of the Department of Agriculture and Rural Development in 2014, the percentage of watering area per area of agricultural land in 2010 at each district can reveal that Xuyen Moc has the greatest shortage of water of the province. The second and the third areas are Long Dien and Chau Duc districts, respectively (Table 19.3) (DARD 2014). For example, Xuyen Moc district has eight irrigation constructions with the capacity for watering about 10,878 ha, but the real watering area is much less than the capacity with only 1.55 % of agricultural land with 798 ha of paddy field.

Furthermore, according to precipitation data in the province at five stations in the period of 1990–2010, rainfall distribution is not equal in the whole province. During the period, the precipitation tends to decrease. For instance, Chau Duc district, a

Table 19.3 The current status of watering areas in BR-VT province

Districts	Irrigation constructions	Watering area (ha)	Agricultural land in 2010 (ha)	Percentage in 2010
Chau Duc	20	1190	35,693	**3.33** %
Tan Thanh	24	1288	19,626	6.56 %
Long Dien	1	120	5371	**2.23** %
Dat Do	6	2665	16,198	16.45 %
Xuyen Moc	8	798	51,345	**1.55** %
Ba Ria	4	717	6002	11.95 %

Source: DARD, 2014

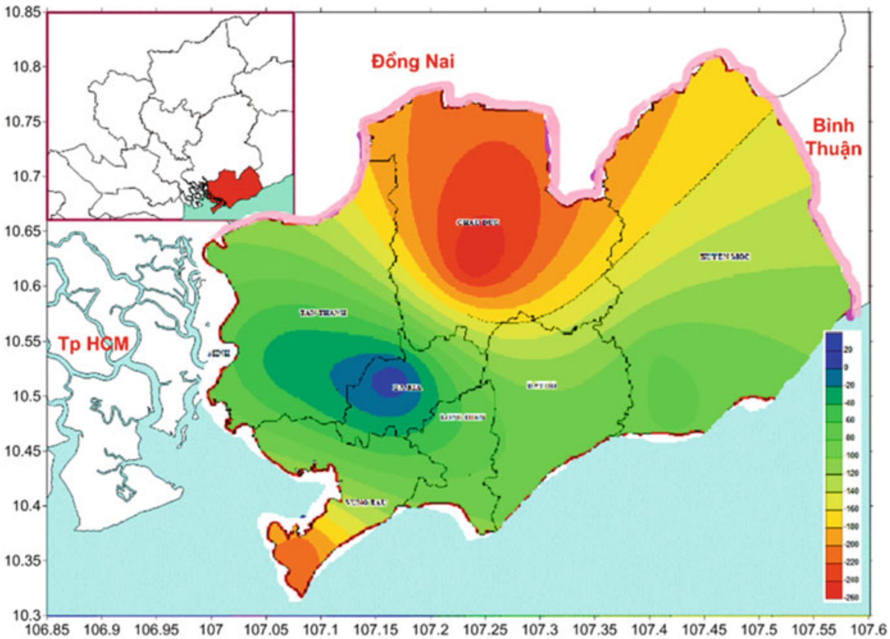


Fig. 19.8 Distribution of mean precipitation differences in BR-VT in 2000s from 1990s

part of Xuyen Moc district and Vung Tau City, has the largest reduction of precipitation from −140 to −260 mm. In the other areas such as Long Dien, Dat Do, and a part of Ba Ria, Vung Tau City, Xuyen Moc, and Tan Thanh district, the quantity of rainfall decreased from 0 to −140 mm. Nevertheless, there is a small area of Ba Ria City that experienced a small increase of rainfall from 0 to 20 mm (Fig. 19.8).

In terms of temperature, temperature data at Vung Tau station during the period 1979–2010 showed the gradual increase in trend. The highest, the lowest, and average temperature had the same increase in trend with 0.026 °C/year, 0.04 °C/year, and 0.024 °C/year, respectively (BRVT PC 2013a).

Table 19.4 Changes in mean precipitation (%) relative to period 1980–1999 in BR-VT province, according to the national medium emission scenario (B2)

Season	2020	2030	2040	2050	2060	2070	2080	2090	2100
Winter (XII-II)	−3.3	−4.8	−6.8	−8.8	−10.7	−12.5	−14.1	−15.5	−16.8
Spring (III-V)	−1.0	−1.5	−2.1	−2.6	−3.2	−3.8	−4.2	−4.7	−5.1
Sumer (VI-VIII)	0.6	0.8	1.1	1.5	1.8	2.1	2.4	2.6	2.8
Fall (IX-XI)	2.8	4.1	5.7	7.3	8.9	10.4	11.8	13.0	14.1
Average	1.1	1.6	2.2	2.9	3.5	4.1	4.6	5.0	5.5

Source: MONRE 2012

Table 19.5 Changes in mean temperature (° C) relative to period 1980–1999 in BR-VT province, according to the national medium emission scenario (B2)

Season	2020	2030	2040	2050	2060	2070	2080	2090	2100
Winter (XII-II)	0.5	0.7	1.0	1.2	1.5	1.8	2.0	2.2	2.4
Spring (III-V)	0.5	0.7	1.0	1.3	1.6	1.8	2.1	2.3	2.5
Sumer (VI-VIII)	0.5	0.8	1.1	1.5	1.8	2.1	2.4	2.6	2.8
Fall (IX-XI)	0.5	0.7	0.9	1.2	1.5	1.7	2.0	2.1	2.3
Average	0.5	0.7	1.0	1.3	1.6	1.9	2.1	2.3	2.5

Source MONRE 2012

Table 19.6 Sea level rise in BR-VT province (cm), according to the national scenarios

Scenarios	2020	2030	2040	2050	2060	2070	2080	2090	2100
A1F1	8–9	13–14	19–21	26–30	35–41	45–53	56–68	68–83	79–99
B2	8–9	12–14	17–20	23–27	30–35	37–44	44–54	51–64	59–75
B1	8–9	11–13	17–19	22–26	28–34	34–42	40–50	46–59	51–66

Source MONRE 2012

According to the national CC medium scenario (B2) in 2012, mean precipitation in the province will have the increase in trend in the coming years. This trend is contrary to the precipitation trend that happened during the period 1990–2010. However, rainfall distribution between the dry and rainy seasons will change considerably (Table 19.4). Similarly, average temperature in BR-VT is projected to be increasing 0.7 °C, 1.3 °C, 1.9 °C, and 2.5 °C by the year 2030, 2050, 2070, and 2100, respectively (Table 19.5).

Temperature rising and precipitation changing lead to more extreme weather events in the future. Drought is likely to occur in the province in the dry season. Partly flood will probably happen in the rainy season.

19.5.4 Sea Level Rise

According to sea level rise scenario, the sea level rise will be at 79–99 cm in BR-VT province with the highest emission scenario (A1F1) by the year 2100 (Table 19.6).

Table 19.7 Flood areas by sea level rise at 01 m (ha)

Districts	Vung Tau	Tan Thanh	Ba Ria	Long Dien	Dat Do	Xuyen Moc	Whole province
Flood area	4770.02	7684.86	1425.24	1012.04	1209.02	513.65	16,614.83
Percentage	31.8 %	22.7 %	15.6 %	13.1 %	6.4 %	0.8 %	8.35 %

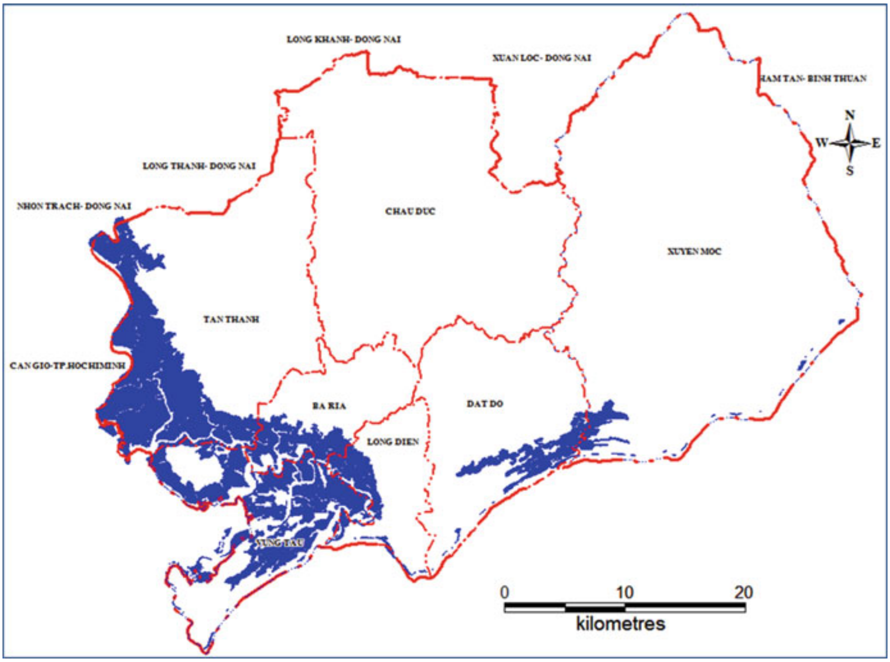


Fig. 19.9 Flood areas in Ba Ria-Vung Tau with sea level rise at 1 m

By analyzing from the existing topographic map, an area with altitude at 00 m to 01 m is identified. This area is close to the sea, and if the sea level rise up to 01 m, the area is likely to be inundated under the seawater. The flood area is calculated about 16,614.83 ha, 8.35 % area of the province, including two cities and four districts. Vung Tau City will be most seriously flooded by sea level rise at 31.8 % of area with 4770 ha. Tan Thanh district is the second flood-prone area with 22.7 %, but it has the biggest impacted area of 7684.86 ha. Xuyen Moc district has the smallest affected area with over 513 ha (Table 19.7) (Fig. 19.9).

By overlaying land use planning map with flood map in blue color, affected regions on land use planning are identified (Fig. 19.10). In case of non-evident countermeasures of prevention, the analysis reveals statistic numbers of flood areas in each affected districts. Vung Tau City has the most serious flood risk by sea level rise. Flooded areas will include 425 ha of urban residential area, 729 ha of industrial zones, 613 ha of public land, and a huge area of forest. In Tan Thanh district, the flood areas will be located in the southeast of the national highway number 1A.

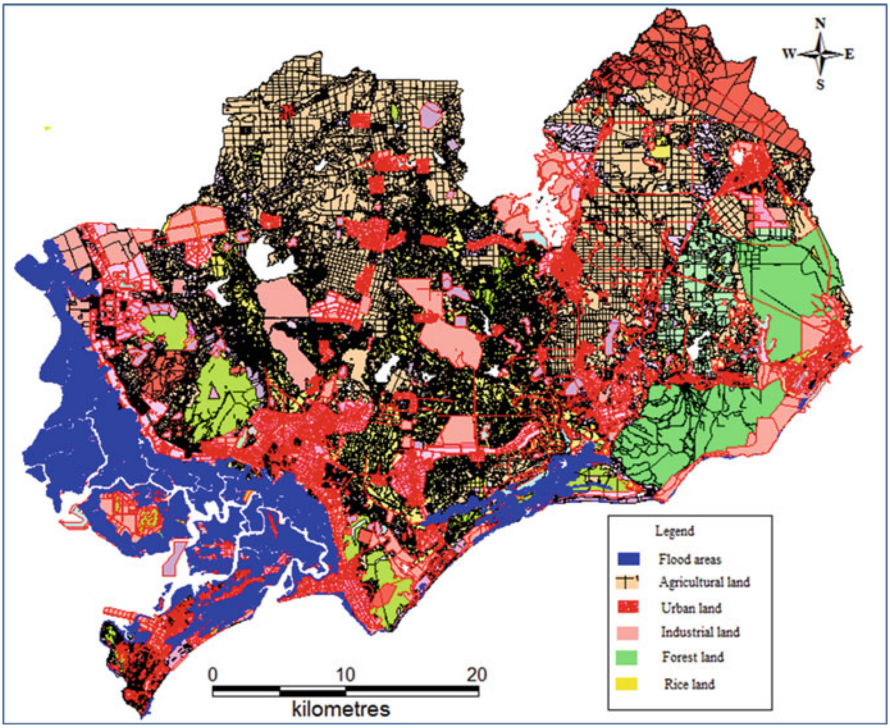


Fig. 19.10 Land use planning up to 2020 overlay with flood areas map

In these areas, LUP mostly involves transport system, industrial zones with 4519 ha, and a large area of protective forest with over 800 ha. By the year 2020, the influenced area will include over 840 ha of transport land including about 30 port projects along Thi Vai River, a system of roads to connect the port system, industrial zones, and a link to Dong Nai province. In Ba Ria City, sea level rise will lead to flooding at a large planning area including public land (207 ha), transport (128 ha), and residential areas (120 ha). At coastal rural areas, Long Dien district will have the largest flood in residential areas of 138 ha. Dat Do district will be inundated over 152 ha of production and business land. And in Xuyen Moc district, the most impacted area will be 167 ha of forest (Table 19.8).

19.6 Local Planners' Perspective of Integration Climate Change into Land Use Planning

A questionnaire survey was conducted via direct interview and email from Feb 10 to Mar 3, 2014. There were a total of 23 questionnaires introduced and there were 20 respondents. Participants are local officials at commune, district, and provincial

Table 19.8 Main kind of land use planning will be affected by sea level rise at 1 m

Land use types	Flood areas (Ha)					
	Tan Thanh	Ba Ria	Long Dien	Vung Tau	Dat Do	Xuyen Moc
Public land	150.96	207.49	72.94	613.23	3.64	1.86
Transport	844.21	128.41	28.95	52.47	28.7	6.17
Forest	804.4			582.02	286.95	167.28
Agriculture	45.71					
Aquaculture	187.8				291.14	130.99
Urban residential		119.58	2.28	425.78		35.11
Rural residential	121.68		138.19		38.93	
Production and business	826.8	37.44	28.6	437.6	152.26	27.32
Industrial zones	4519.26	33.78	4.27	729.59	2.07	
Total	7612.59	526.7	275.23	2840.69	1207.37	480.15

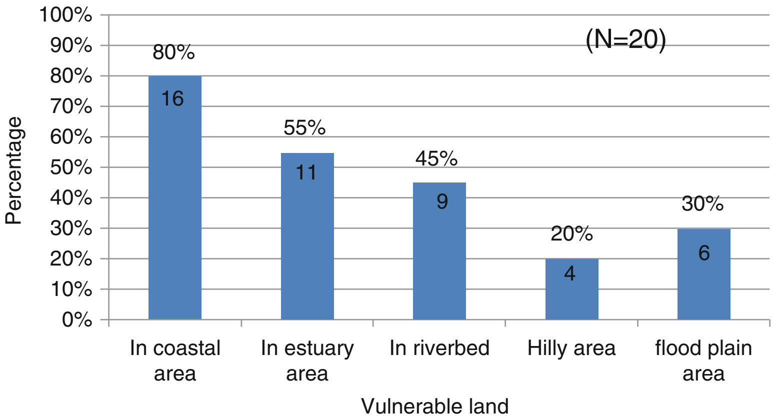


Fig. 19.11 Location of vulnerable land

level, who are members in LUP processes. The survey results show that the most vulnerable land is in the coastal area. Typical disasters are coastal erosion, riverbank erosion, and typhoon. The capacity of local planner is strong in taking high priority about environmental issues, but their capacity to address CC issues is limited (Figs. 19.11, 19.12, and 19.13).

The local planner's capacity is evaluated by applying Climate Change Disaster Initiative (CDRI) method (Joerin and Shaw 2011). The parameters for CDRI include environmental priority, political commitment, internal resources, personnel, technical ability, and collaboration. Each parameter is graded with a score from 1 to 5 and from the lowest to the highest, respectively.

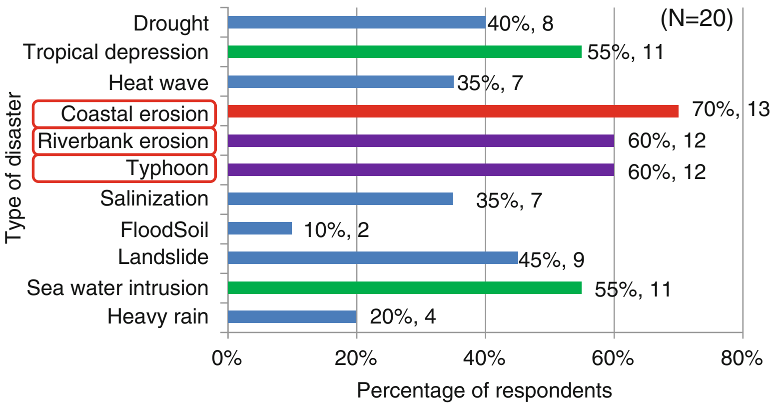
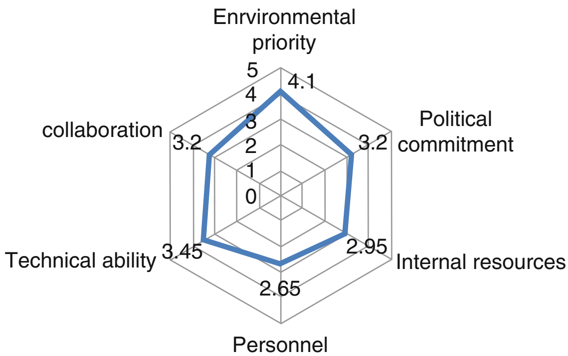


Fig. 19.12 Type of climate-related disaster

Fig. 19.13 Local planners' capacity



19.7 Discussions and Recommendations

The current LUP in BR-VT focused more on social and economic development. It can be considered as a non-risk-sensitive LUP. Particularly, LUP concentrates on social-economic development targets rather than climate hazard risks. Indeed, along with the national economic development, BR-VT has a rapid urbanization and industrialization pace. LUP of the province follows the national LUP and the social-economic development targets of the province. However, the CC impacts on land use and disaster risks are ignored. This weakness resulted from several reasons. The first reason is ineffective implementation of LUP and CC legislation in mainstreaming CC into LUP. The second reason is the lack of CC information. In fact, the LUP for the period 2010–2020 was processed in 2009. At this time, the latest national CC and sea level rise scenarios of 2009, which is developed by the Ministry of Natural Resources and Environment in 2009, was the only one official CC document. This document mainly contains the national and regional CC scenarios. It lacks the local

CC assessment information. The third reason is the limitation of the official's capacity in addressing CC issues. The last reason is there is no practicable CC information because of the lack of community contributions due to the top-down land use planning process.

Generally, BR-VT has been vulnerable to coastal erosion, temperature rise, rainfall variation, and drought. The current observations reveal that typhoon in the East Sea tends to occur later than before and moves southward of Vietnam. Therefore, BR-VT province is likely to be more vulnerable to typhoon in the future. The study analysis shows that among coastal areas, Vung Tau City, Xuyen Moc, and Tan Thanh district are considered the three most vulnerable to climate change impacts and have the largest LUC area.

The study suggests a framework to integrate CC issues into LUP (Fig. 19.14). The framework is developed based on the conception of urban climate change resilience (Tyler and Moench 2012). In the framework, Climate Change Coordinate Office (CCCO) should be established based on the existing climate change response

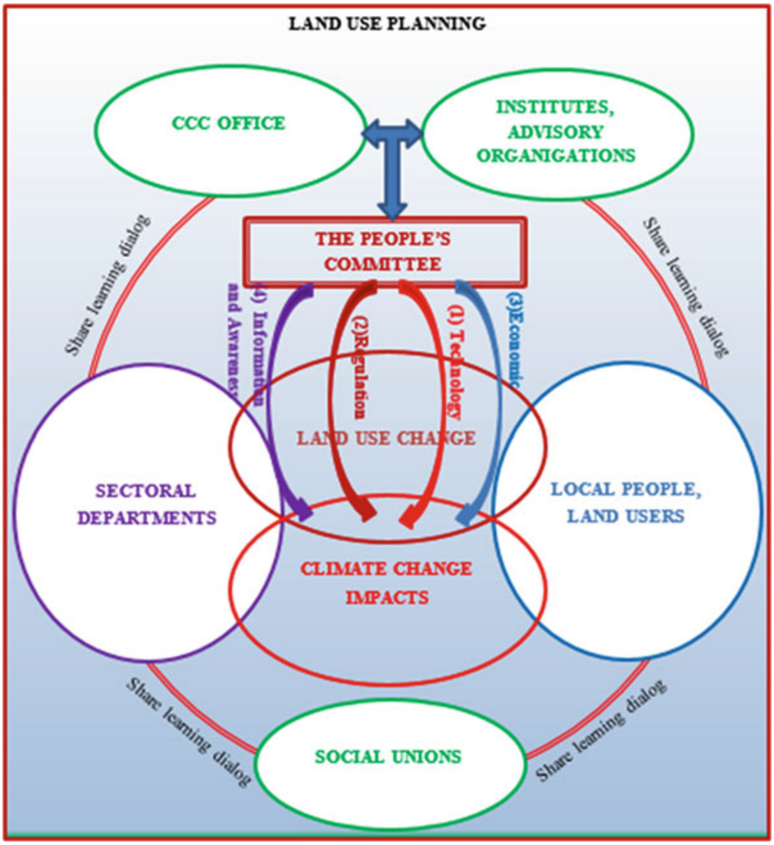


Fig. 19.14 Framework of integration CC into LUP

responsibility body at provincial level, but it can connect departments and social unions as well as inhabitants (Network 2013). It will support the province's People's Committee to make the right decision on climate resilience for not only LUP but also other sectors' planning. The CCCO is consulted or supported by experts and scientists of advisory organizations. The consultative organizations can be a national and international research institute or NGO. The CCCO and the advisory organization work closely with local stakeholders at the climate vulnerable prone areas, by using share learning dialog (SLD) method (Reed et al. 2011) to combine local and scientific knowledge to assess CC impacts in relation to LUP. Through SLD approach, impacts of negative CC on institutions and on agents will be discussed thoroughly. Besides, stakeholders and officials can raise their awareness not only about CC issues but also land use policies during the interaction with experts and planners. The social unions include both governmental and public organizations such as the Farmer Union, Women Union, Youth Union, and Ageing Union. These organizations play an important role in collaborating individuals. They also will participate in carrying out the approaches. There are three good practices about the CCCOs in Vietnam. The CCCOs have shown the proactive role in building CC resilience since they were founded in 2011 at Can Tho City, Dang City, and Quy Nhon City-Khanh Hoa province. These three cities are supported in the ACCCRN (Network 2013).

According to the Land Law 2013 and related legislations, there are no guidelines to conduct CC impacts assessment. The practical tools for analyzing CC impacts are directly interview inhabitants or tenants. During LUP process, the advisory organization should collaborate with CCCO to conduct questionnaire or FGD to analyze the CC risk as well as land use limitation.

The framework also suggests four groups of measures including the regulatory system, technology, economic measure, information system, and awareness raising. These solutions are also divided into two main kinds including "hard" measures (construction includes physical infrastructure, installation of equipment, building facilities, etc.) and "soft" measures (nonconstructions include institution, operation, policies, training, etc.) depending on short-term, medium-, and long-term impacts (Adaptation 2010). Depending on the kind of CC impacts, the relevant groups of measures will be chosen to solve the problems. It means that a problem can be resolved by one or more than one group of measures. The following approaches introduced below will be encouraged to mainstream into not only LUP but also other sectors' planning.

19.7.1 The Measures to Incorporate Coastal Erosion Issues into LUP

To deal with the short-term effects, the technological approaches aim to build control facilities on slopes which can be applied immediately to prevent loss of land resulted from coastal erosion along the coastline from Vung Tau City to Xuyen

Table 19.9 Approaches to encompass coastal erosion into LUMPP

	Approaches that help to prevent and mitigate short-term effects	Approaches that help to prevent and mitigate medium- and long-term effects
Technological approaches	● Improve and build erosion control facilities on slopes	○ Keep research to find the causes for countermeasures
	● Protect and plant trees on sand dunes along coastlines	● Build works to prevent coastal erosion
	● Plant trees on alluvial land along riverbanks	
	○ Reassess land use projects, which convert mangrove forest into other purposes	
Regulatory approaches	○ Integration of coastal erosion assessment into LUMPP	● Resettle local residents
	○ Prohibit illegal sand mining in beach and in river mouth	
	○ Restrict building houses and offices	
Information system and awareness raising	○ Provide information about coastal erosion for assessment and research and broadcast on the media	
	● Making coastal erosion map panels at erosion sites for danger awareness	
	● Community and public union participation in LUMPP process for raising awareness of people about coastal erosion	

● Indicates "hard" measures
○ Indicates "soft" measures

Moc district. Trees should be planted on sand dunes, alluvial land, and along riverbanks to prevent from erosion and blowing away. Thus, it is necessary to reassess land use projects on mangrove forest land to evaluate the potential risks and choose relevant mitigation approaches (Table 19.9).

The regulatory approaches tell that the coastal districts should deal with coastal erosion issues, and this must be considered and incorporated into LUP. They also should restrict and monitor strictly sand mining activities. Illegal sand mining activities can lead to coastal or riverbank erosion in the adjacent areas. Houses and offices should not be allowed to be built in the areas.

Information system and awareness raising methods related to coastal erosion should be widely provided and be accessible for assessing and researching purposes. For example, it can be broadcasted on the local media as a television program. Coastal erosion knowledge can be disseminated to local individuals through participation of LUP process. Coastal erosion map panels should be located at erosion sites to be aware of dangers.

To deal with the long-term effects, the technological approaches are the responsibility of the Department of Science and Technology which should undertake research to find suitable countermeasures such as learning from other countries' experiences of assessing beach erosion and countermeasures. Depending on the scale of coastal erosion and results of further research, construction will be decided such as wave sheltering or resettlement areas.

19.7.2 The Approaches to Encompass Sea Level Rise into LUP

These approaches are suitable for applying in Vung Tau City, Ba Ria City, and Tan Thanh districts, which are projected to be flooded by SLR. To cope with the short-term impacts, the regulatory approaches are the most important. The province should introduce building code at low-lying areas and update gradually the CC and sea level rise scenarios. However, the regulation of the building code is likely to bring an adverse influence on land price and real estate and push up the cost of constructions (Sudmeier-Rieux et al. 2014). In addition, the province should promote to retain wetland and protect mangrove areas because of its multivalued ecosystem role (Mitra 2013). For example, allotment of wetland to local people to protect and develop mangrove forest.

The technological measures for short-term impacts are to reinforce and raise the house foundation (Table 19.10). The initiative of the approach was introduced by a project of "Storm and Flood Resistant Credit and Housing" in Da Nang City, Vietnam (Network 2013). This house can keep householder safe from not only storm but also from flood (Fig. 19.15). But low-income stakeholders are accustomed to a simple structure house or weak house because of low cost and rapid construction process. It is likely that implementation risk-resistant building regulations will be a trouble to them if the local government has no incentive policies to promote local people to comply with the building code. Thus, this method should be carried out together with economic approaches. The government should encourage and introduce a financial support program so low-income householders can repair or strengthen their house. For infrastructure, the street Lien Cang Cai Mep along Cai Mep River in Tan Thanh district can be upgraded as a dike to prevent inside land from seawater intrusion. In general, the building code of infrastructure constructions is just based on the highest flood level observed in the past (Sudmeier-Rieux et al. 2014). This elevation is not suitable with the SLR scenarios. Hence, the cost of building will increase much more than before. For long-term impact approaches, the local goverment should keep researching for causes, countermeasures and providing new breed of resistant-saline trees to farmers. Moreover, the government should build and reinforce public works to be used as evacuation places for emergency cases.

For economic approaches, the local residents are accustomed to living in coastal and riverbank areas because of convenient livelihood such as agricultural and fishing activities, commercial and tourism services, and convenient transportation.

Table 19.10 Approaches to encompass sea level rise into LUP

	Approaches that help to prevent and mitigate short-term effects	Approaches that help to prevent and mitigate medium- and long-term effects
Technological approaches	● Reinforce and raise house foundation	○ Keep research to find the causes for countermeasures
	● Improve and build sea dikes	○ Provide new breed of trees that withstand saline
	● Upgrade and installation of new warning hazard systems	
	● Application storm- and flood-resistant house in hazard zones	● Build evacuation center
	● Reinforce road line as a dike	● Reinforce public constructions for use as evacuation places
	● Protect and plant tree on sand dunes along coastlines and on alluvial land	
Regulatory approaches	○ Update climate change and sea level rise scenarios	● Build resettlement
	○ Allotment of forest land	
	○ Introduce building codes at low-lying areas	
	○ Protect mangrove forest land	
Economic approaches	○ Encourage eco-tourism, riverside and forest eco-tourism	○ Introduce disaster insurances
	○ Utilize environmental protection funds	
	Incentive policies	
Information system and awareness raising	○ Provide information about hazard and broadcast on the media	
	● Making SLR map panels at influential areas for danger awareness	
	○ Community, social public union participation in LUMPP process also for raising awareness of people about land use policies	
	○ Rehearse regularly to prevent from flood	

● Indicates "hard" measures
○ Indicates "soft" measures

Therefore, the government authority should encourage to develop eco-tourism by taking advantage of a good landscape of riverside and forest. Furthermore, they can provide financial supports for developing and protecting mangrove forest schemes by utilizing environmental protection fund. In the long-term, the central government should introduce disaster insurances for individuals as well as companies. Besides, the government should introduce incentive polices to support for the increase cost of constructions such as reduction of land taxes and land use levy. The government should also offer loans for vocational training and develop social houses. In terms of information system and awareness, the information of SLR and flooding maps

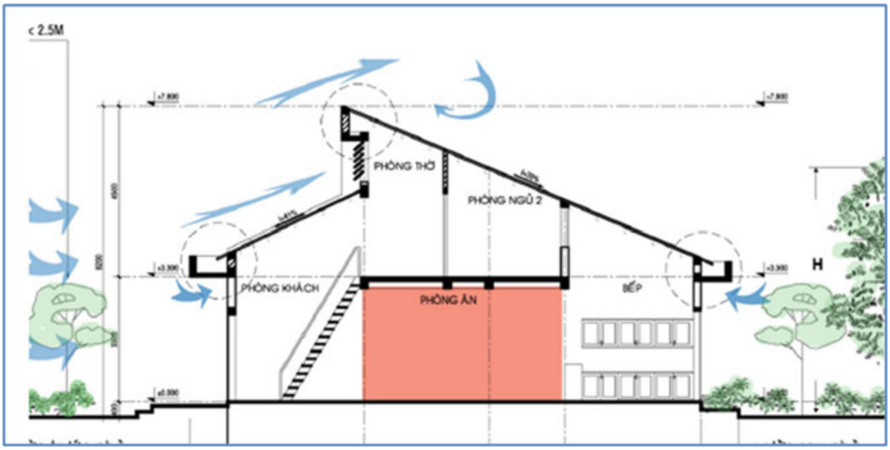


Fig. 19.15 Storm-resistant house (Source: (Phong 2013))

should spread to all sectors and agencies to integrate into sector development plans as well as to build action plans to respond to SLR. For example, it can be broadcasted on the local media as a television program. In addition, to raise awareness of people at flood-prone area, local government should introduce flood hazard maps. SLR can aggravate coastal erosion and seawater intrusion (Church 2010). Therefore, the approaches for coastal erosion should be considered simultaneously such as planting a tree on sand dunes along coastlines and on alluvial land. Finally, local government should cooperate with experts and communities to organize regular drills about how to prevent and mitigate flooding.

19.7.3 The Approaches to Encompass Drought Risk into LUP

Water is always important for land use. In BR-VT, water supply systems are mainly based on the groundwater resource. The surface water is used for living and agricultural activities. But most agricultural land is located on plain topography. It is a disadvantage for irrigation development. In the context of CC, groundwater has been reduced its level. Drought is occurring partly. Drought risks will exacerbate the risk of saline due to SLR and reduction of groundwater level. Therefore, local government should speed up building the irrigation planning. And the study suggests some countermeasures to drought.

These approaches are needed for Xuyen Moc, Long Dien, and Chau Duc districts, which are considered to be more exposed by drought (Table 19.11). For the short-term impacts and in term of the technological measures, it is very important to prevent the instrution of seawater by building seawater break constructions in the Dinh and Ray Rivers estuary areas. Local government should build desalination plant in

Table 19.11 Approaches to encompass drought into LUP

	Approaches that help to prevent and mitigate short-term effects	Approaches that help to prevent and mitigate medium- and long-term effects
Technological approaches	● Desalinization of seawater, delivery of freshwater supply	○ Keep research to find the causes for countermeasures
	○ Support new breed of trees that withstand saline, drought-tolerant trees	○ Green parks for water storage
	○ Encourage new cultivation methods	● Delivery of freshwater from other source in neighbor provinces
	○ Switch one crop paddy field to fresh vegetables, ornamental plant, fruit trees, and livestock	
Regulatory approaches	○ Protect two and three crops of rice land	
	○ Protect forest land	
	○ Mainstream CC into irrigation planning	
Economic approaches	○ Support local people to build water storages	○ Introduce disaster insurances
Information system and awareness raising	○ Provide information about drought hazard and broadcast on the media	
	○ Community, social public union participation in LUMPP process also for raising awareness of people about land use policies	

● Indicates "hard" measures
○ Indicates "soft" measures

coastal areas, where water resource is limited, to add quantity of freshwater supply for living and agricultural activities. Besides, the agricultural extension services should encourage and support farmers to apply hydroponics and drip irrigation. It also provides the new breed of drought-tolerant trees to cultivators. In addition, farmers should be encouraged to switch low-yield paddy land into other annual crops for effective land use. The regulatory approaches focus on food security by issuing policy to remain the two and three crops paddy land. Irrigation system is prioritized for this kind of paddy land area. The economy approaches are to support local low-income people to build water storages. Finally, information about drought hazard should be openly accessed by taking advantage of participation of community and social public unions in LUP process. It is also can be spread out by media.

For long-term effects, LUP should set aside a specific space for green parks to store water in soil. Local government should encourage individuals and enterprises to develop more green constructions such as green rooftop works. There should be cooperation with Dong Nai and Binh Thuan provinces to protect the head forest and plan to deliver another source of freshwater to BR-VT province in case of water scarcity in the future. In terms of policies, protect high-yield paddy fields and cooperate with other provinces to protect headwater forest land. In term economic methods, the local government should promote to introduce disaster insurances to vulnerable communities.

19.7.4 The Approaches to Integrate Storm Risk into LUP

Storm is always associated with heavy rain, flood, and SLR. Therefore, in general, these measures are similar to the countermeasures for SLR. These approaches are needed for the coastal district from Vung Tau to Xuyen Moc district, with its long coastline facing the sea (Table 19.12). In addition, for short-term effects, the local government should install an early warning system. Besides, the information of the

Table 19.12 Approaches to encompass storm into LUP

	Approaches that help to prevent and mitigate short-term effects	Approaches that help to prevent and mitigate medium- and long-term effects
Technological approaches	● Upgrade and installation of new early warning hazard systems	○ Keep research to find the causes for countermeasures
	● Improve and build canals, dikes, breakwaters, storm surge barriers, and sewerage facilities	○ Improve infiltration of water in land
	● Introduce storm- and flood-resistant house in hazard zones	● Build evacuation center
	○ Protect and plant tree on sand dunes along coastlines	● Reinforce public constructions for use as evacuation places
Regulatory approaches	○ Protect mangrove forest land	
	○ Update climate change and sea level rise scenarios	
	○ Introduce building codes at low-lying areas	
Economic approaches	○ Utilize environmental protection funds	○ Introduce disaster insurances
	○ Incentive policies	
Information system and awareness rising	○ Provide information about storm hazard and broadcast on the media.	
	○ Draw hazard maps for storm risk and seawater flood	
	○ Community, social public union participation in LUMPP process also for raising awareness of people about land use policies	
	○ Rehearse regularly to prevent from storm	

● Indicates "hard" measures
○ Indicates "soft" measures

Fig. 19.16 Pavement construction (Source: World Bank institute and http://www.lrc.usace.army.mil)

storm risk should be immediately and frequently disseminated to people through media for proactive preparedness and mitigation approaches.

For the medium- and long-term effects, the government should consider improving the infiltration of water in land such as green space, pavement in roads, parking areas, and public places which are good methods to allow water to infiltrate into soil (Fig. 19.16) (Institute 2013).

In summary, the relationship between LUP and CC policies has been developed since the effect of the NTP-RCC in 2009. However, the integration of climate change issues has not taken into account into LUP at local levels because of lack of climate change information and limitation of local official's capacity. In the coming time, the Land Law 2013 and related legislations may ensure the implementation of the mainstreaming of CC matter into LUP.

Besides, the study shows that BR-VT is a dynamic social-economic development province in the southeast region of Vietnam. It has a rapid land use change progress to satisfy the high pace development in business, industry and services. In addition, the province has been affected seriously by climate change-related impacts such as coastal erosion and drought. In the future, the province is projected to be severely flooded by sea level rise especially in Vung Tau City, Ba Ria City, and Tan Thanh district. These CC impacts will probably obstruct in realization of LUP objectives.

In the coming years, LUP at BR-VT province should be revised and incorporated climate change issues. The study comes up with several countermeasures to mainstream coastal erosion, sea level rise, drought, and storm risk into LUP. These suggestions may also be useful for other sectors' planning.

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Chapter 20
Land Use Change in Southwestern Coastal Bangladesh: Consequence to Food and Water Supply

Gulsan Ara Parvin, Md. Hashan Ali, Kumiko Fujita, Md. Anwarul Abedin, Umma Habiba, and Rajib Shaw

Abstract The coastal area in Bangladesh constitutes about 32 % of the country. This one-third of the country's land is recognized as a zone subject to intensive human use. Land use in the coastal Bangladesh is diverse, competitive, and conflicting. Over the last half-century, coastal land uses of Bangladesh have gone through major changes. Since the 1950s natural disasters like cyclone and tidal flooding, salinity intrusion, large-scale polderization, and intensive shrimp farming have changed the whole coastal area of Bangladesh. Especially, these changes are prominent in the southwestern coastal belt. Consequently these changes in coastal land uses have induced significant impacts on agriculture, crop production, food and water supply, and livelihood of southwestern coastal community. This paper is an attempt to conduct a trend analysis of coastal land use changes in Bangladesh. It highlights the responsible factors behind the coastal land use changes. Further, it examines the impact of coastal land use changes in agricultural production, food, and water supply.

Keywords Land use change • Southwestern • Coastal Bangladesh • Food and water supply

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20.1 Introduction

Change in the use of land is a constant process. With the pace of development initiatives and interventions, lands in different parts of the world are changing. The United Nations' Food and Agriculture Organization (FAO), Water Development Division, explains that "Land use concerns the products and/or benefits obtained from use of the land as well as the land management actions (activities) carried out by humans to produce those products and benefits" (FAO 2013). It plays a vital role for many planning and management activities concerned with the surface of the earth. Therefore, information and diversified data related to land use are needed in the analysis of environmental processes and problems that must be understood if living conditions and standards are to be improved or maintained at current levels (Anderson et al. 1976). The concept of land use and sustainable land management evolved since the world population began to explode. Knowledge about land use and land cover has become increasingly important as the nation plans to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands, and loss of fish and wildlife habitat.

For a small, populous country like Bangladesh, it is a foremost requirement to ensure efficient management of scarce land resources. However, due to lack of effective policy planning, zoning, and land use planning and regulation and lack of the enforcement of law and order, Bangladesh is embracing diversified threats and vulnerabilities to its scarce land resources. Especially, due to rapid, uncontrolled, and unplanned land use changes, the coastal areas of Bangladesh are facing sluggish socioeconomic development, threats of different disasters, environmental degradation, and global climate changing process (DoF 2005). It is claimed that about 50 % of the coastal lands of Bangladesh face different degrees of inundation, thus limiting their effective use (Islam 2006a). It also warns that the inundation situation is expected to worsen further because of the effects of climate change. This vulnerable coastal zone covers 19 out of 64 districts, where 30 % of the total populations of Bangladesh live and more than half of them are poor (Parvin et al. 2009). Further, the population in the coastal areas is expected to increase from 36.8 million in 2001 to 43.9 in 2015 and to 60.8 million by 2050. Therefore, present per capita agricultural land of 0.056 ha will decrease to 0.025 ha by 2050 (Islam 2006b).

The coastal area, which is one-third of the territory of Bangladesh, went through major changes over the last half-century largely due to frequent and diverse natural disasters with direct and indirect impacts on land resources and its various uses. Land is being degraded and lost due to the effects of increased salinity intrusion, inundation of low-lying marshy land, floods, and land erosion by the unplanned and haphazard land use of people. These unplanned and haphazard land uses, along with salinity are changing the traditional cultivation and replacing hybrid yields as well as shrimp farming in the coastal areas. Therefore, coastal areas had a dramatic shift in last decades. These dramatic changes in land use and shift of farming system in the coastal area have induced adverse environment impacts and hamper normal crop production throughout the year. Consequently, these impacts directly change the food and water supply scenario throughout the households and enhanced the hardship in their daily life (Rasel et al. 2013; Parvin and Ahsan 2013). Further, due to increasing degree of salinity of coastal areas, normal crop production becomes more restricted, and people are migrating to the urban areas for livelihoods as they have little access to works due to less demand of working labor in the shrimp farming.

Due the present context of scarce land resources and its degradation, knowledge about land use change, responsible factors behind that, and its impacts on life and livelihood are quite important field of research and interventions. Since coastal land is in intensive human use in Bangladesh and it is changing in a rapid pace, considerable numbers of researches on land use have been conducted. However, almost all of them are either about temporal change detection of land use or land use classification. Moreover, a number of researches have been conducted on urban areas, focusing on urban growth or environmental changes because of coastal hazards and climate change. There are some studies that indicate land use changes and impact on agriculture. Studies that focus on the coastal land use changes have attained high interest since the last few decades, especially, since the 1980s when coastal areas of Bangladesh started to embrace massive changes in land use due to the emergence of shrimp farming. Among these, Rabbani et al. (2013a), Rasel et al. (2013), and Karim (2006) are few studies that focus on the coastal land use changes and its adverse impact on agriculture. However, single studies that combine trend of coastal land use change, causes, and impacts are not available. Therefore, this study is an attempt to provide a whole picture of coastal land use change by focusing on the southwestern part of Bangladesh. This paper attempts to conduct a GIS-based analysis of coastal land use changes in Bangladesh. It aims to examine the reasons behind rapid land use change in southwestern coastal area and the impacts of coastal land use changes to food and water supply. Further, this paper intends to observe how the daily life of coastal community has been altered to face these changes.

20.2 Trend Analysis of Land Use Changes in Southwestern Coastal Bangladesh

Similar with the other parts of the world, coastal areas of Bangladesh have embraced diversified land uses with intensive human activities. Most common land uses are agriculture, livestock rearing, fishing, shrimp culture, and salt production, and human activities include export processing zones (EPZ), airports, land ports, harbors, and tourist sites. Moreover, World Heritage Site Sundarbans and ecologically critical coral ecosystems are the most important land uses in coastal Bangladesh.

Coastal zones of Bangladesh (Fig. 20.1) are considered as areas of enormous potentials. At the same time, the government has identified the zone as an "agro-ecologically disadvantaged region" (GoB 2005). Scarcity of drinking water, land erosion, the high groundwater arsenic content, waterlogging, water and soil salinity,

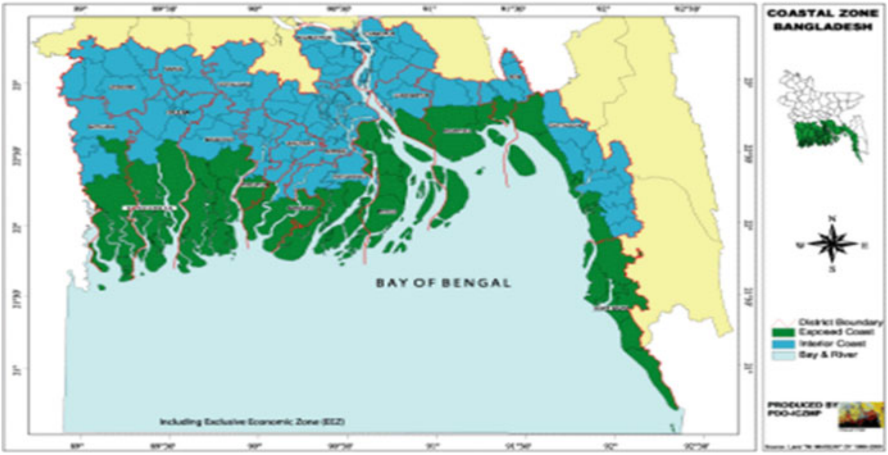

Fig. 20.1 The coastal zone of Bangladesh (Source: Islam et al. 2006)

and various forms of pollution have also slowed down social and economic developments (Islam and Ahmad 2004). Frequent natural disasters, environmental degradation, and global climate changing process have induced additional vulnerabilities and rapid changes in coastal areas, especially to the southwestern part, which faced two devastating cyclones (SIDR and Aila) within less than half a decade.

20.2.1 Land Use Change in Southwestern Coastal Bangladesh

Land use change is a constant and rapid phenomenon in Bangladesh, and agricultural land is shifting to nonagricultural uses in an alarming rate (Planning commission, 2009, cited in SRDI 2013). A census on land resources reported that every day 220 ha of arable land is converted for other uses like constructions of houses, roads, commerce, and industries and for other nonagricultural activities, which is very frightening for the sustainability of land resources of the country (SRDI 2013). Table 20.1 shows land cover changes of overall Bangladesh in the years 1976, 2000, and 2010.

Though lands are the most demanding and valuable resources, these are now under threat due to unplanned uses for shrimp farming, settlements, infrastructural development, and meeting other demands of the people in the southwestern coastal belts. The land in the southwestern coastal belt is intensively used for agriculture, shrimp (bagda) culture, mixed (bagda and white fish) culture with paddy, settlements with homestead forest, close water body, rivers, and canals and for other infrastructural developments. Southwestern coastal zone is containing rich aquatic and terrestrial resources and mangrove forest Sundarbans. It is noticed that this land use in the coastal zone is diverse, competitive, and often conflicting (Alam et al. 2002;

Table 20.1 Land use change in Bangladesh over 30 years

	Land cover/use	Areas in % (1976)	Areas in % (2000)	Areas in % (2010)
Agricultural land	Cropland	67.38	64.96	60.04
	Forest	12.11	9.02	9.84
	Mangrove	3.12	3.35	3.03
	River	6.29	6.11	6.44
	Lake	0.35	0.4	0.35
	Beel-haor	1.66	1.73	1.72
	Aquaculture	0.004	0.99	1.21
	Tea	0.83	0.95	0.66
	Salt pan	0.08	0.17	0.25
	Total agricultural land	**91.83**	**87.69**	**83.53**
Nonagricultural land	Rural settlement	6.11	10.03	12.12
	Urban and industrial	0.18	0.33	0.6
	Accreted land	1.87	1.95	3.75
	Total nonagricultural land	**8.17**	**12.31**	**16.47**
Total land area		**100**	**100**	**100**

Source: Soil Resource Development Institute (SRDI) 2013

Islam et al. 2006). Natural disasters, climate change and human interventions are constantly inducing rapid changes in the southwestern coastal land uses and consequently the lives and livelihoods of the community are changing. Southwestern coastal area, which is one of the ecologically sensitive zones, has embraced rapid changes since over the last three decades. Emerging needs and diversified farming practices have been changed more frequently in southwestern coastal areas (Table 20.2). Data of land use changes in southwestern coastal areas since the last 30 years denote rapid decrease in agricultural land compared to other parts of Bangladesh.

Table 20.2 reveals that, in the 1980s, after the initiation of Coastal Embankment Project (CEP) by the World Bank, agricultural production has been performed and paddy cultivation was most dominantly used in agricultural areas with 68.42 % and that time only traditional shrimp farming was practiced in the lowland. In the 1980s most of the people adjacent to coastal belt were directly or indirectly involved in the collection of resources from the Sundarbans. But the changes in land use occurred because of the intensification of paddy cultivation with the attempted expansion of modern varieties and conversion of agricultural land to nonagricultural use (Sereno 1981).

In the 1990s, southwestern coastal Bangladesh experienced drainage congestion inside and heavy siltation outside the polders because of extensive polderization of the hydrodynamically active delta, and subsequently the achievements from polderization gradually evaporated (Islam et al. 2006). The area became unsuitable both for agriculture and, in extreme cases, even for human habitation.

Table 20.2 Land use change in southwestern coastal zone in the last 30 years

Land use/cover	1980 (%)	1995 (%)	2010 (%)	Change in the1980s	Change in 1995
Agriculture land	68.42	42.53	37.47	0.62	0.55
Fallow/wetland	4.30	2.32	2.66	0.54	0.62
Forest	1.10	1.19	1.10	1.08	1.00
Settlements with homestead forest	14.97	17.13	26.34	1.14	1.76
Shrimp area	2.34	31.51	24.51	13.46	10.47
Urban area	0.02	0.04	0.37	2.23	0.18
Water body	5.37	3.99	5.21	0.74	0.97
Others	3.48	1.29	2.34	0.37	0.67
	100.00	100.00	100.00	1.00	1.00

Source: These data are extracted from GIS attribute which was collected from the SRDI (2013) and analyzed through Excel by authors
Note:
The ratio of (1995 changes/1980 change) the 1980s and 1995 is the changes in the 1980s
The ratio of (changes in 2010/1980s change) the1980s and 2010 is the changes in 1995

In 1995, within a very short time after the1980s (15 years), people changed their traditional paddy cultivation to shrimp farming, which was internationally demanded and high priced. In the1980s, the shrimp areas were only 2.34 %, and in 1995, these land uses dramatically shifted to the unimagined percentages to 31.51 %, and that time people started deforestation in a massive way for making profit in cultivating shrimp through salinity intrusion which also creates land use conflicts to the musclemen and small farmers who own small parcel of lands. In this time period, shrimp farming increased 13.46 times from the 1980s. But in 2010, the shrimp farming is also decreased at a tiny rate because of virus attack, illegal gel pushing, and continuous loss in shrimp farming in the last couple of years, and banned shrimp import from Bangladesh by European Countries made the situation worse, which finally changed the overall land use in the southwestern coastal areas and tried to incorporate HYV rice and vegetables and adapt in the transformed land. But still now, shrimp farming is established as an important industry, contributing 5.2 % to GDP, and the second-highest foreign exchange earner of the country. Shrimp areas expanded from 51,812 ha in 1983 to 137,996 ha in 1994 and to 141,353 ha in 2008 (DoF 2008).

In order to denote the expansion of shrimp farms and the land use changes in southwestern coastal areas, since 1980–2010, the Geographic Information System (GIS) has been used and maps have been developed. In this GIS-based land use change detection process, the base map was collected from the Center for Environmental and Geographic Information Services (CEGIS) ;mouza-wise land use information was collected, shared, and cross-checked with the local office of SRDI; and finally dominant land use types were inputted in the GIS attribute system for further map preparation.

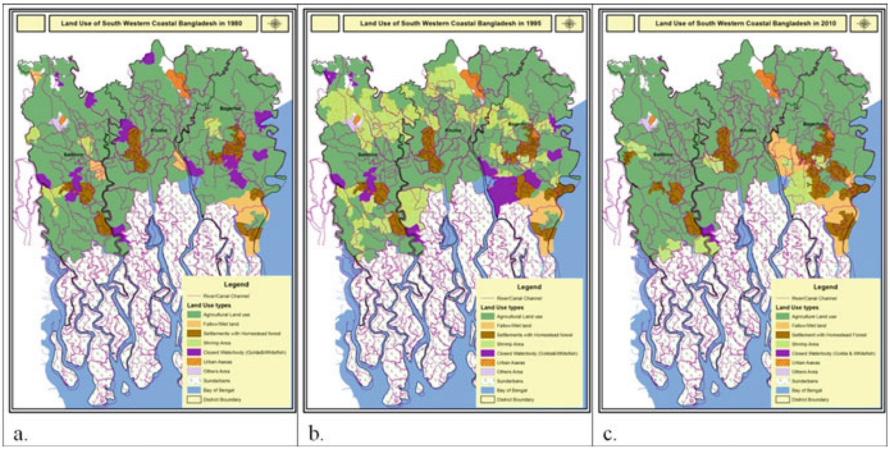

Fig. 20.2 Land use maps of southwestern coastal area showing the change from 1980 to 2010. (**a**) Land use map in 1980. (**b**) Land use map in 1995. (**c**) Land use map in 2010

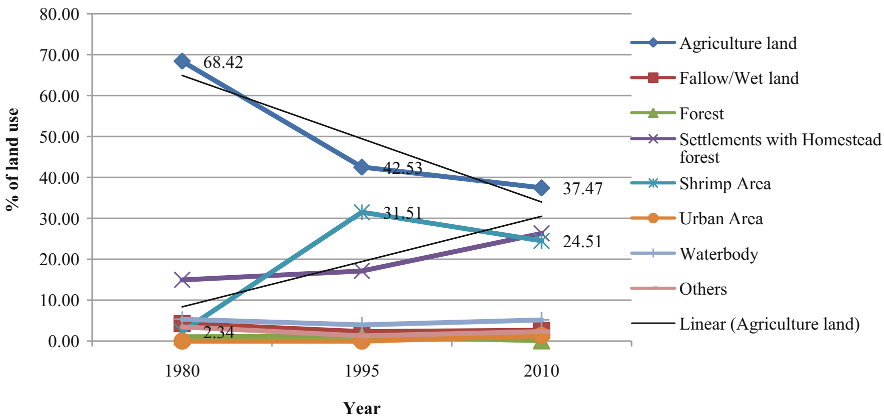

Fig. 20.3 Comparisons of land use changes in 1980, 1995, and 2010 (Source: Adopted by Author from SRDI 2013)

Figure 20.2 clearly implies that, in 1980, agricultural practices (green color) were the most dominant in the whole southwestern coastal areas including Satkhira, Khulna, and Bagerhat districts. Shrimp farming was introduced in the Satkhira and Bagerhat districts more quickly than Khulna. In 1995, the whole picture has been changed, and shrimp farming took place in the whole coastal area, but in 2010, the shrimp farming practices have been decreasing, but in line with this, agricultural practices were getting its dominant situation again. Similar to the maps presented in Fig. 20.2, here Fig. 20.3 denotes the trend of land use changes in different sectors through graphical presentation.

From Fig. 20.2, it is clearly noticed that within one and a half decade, from 1980 to 1995, agricultural land dramatically shifted to shrimp farming in the southwestern coastal belt. Figure 20.3 shows numerical evidence of these land use changes, where within 15 years of agricultural land use reduced from 68.42 % to 42.53 % (about 1.6 times less), while land covered by shrimp farming increased about 15 times. However, this shifting rate slowed down from 1990 to 2010. After 1995, the shrimp industry fails to ensure the quality as per international requirement. Shrimp are injected with fluids and other substances or immersed in water to increase their weight. Sometimes diseases in the shrimp farms could not be controlled properly. Therefore, in 1997, the European Union (EU) imposed a ban on Bangladeshi shrimp (Nupur 2010). Complex and competitive market system, corruption and mismanagement at the farm and processing level, and lack of effective policy intervention and monitoring by the government and international policy have restrained the growth and flourish of this potential sector.

20.3 Causes of Land Use Changes in Southwestern Coastal Bangladesh

About 32 % of the lands of Bangladesh are recognized as coastal zone, and this zone is subject to intensive human use (Islam et al. 2011). Over the last half-century, coastal land uses of Bangladesh have gone through major changes. Since the 1950s, salinity intrusion, natural disasters like cyclone and tidal flooding, large-scale polderization, and intensive shrimp farming have changed the whole coastal area of Bangladesh. There are mainly two major causes that influence land use change: one is the human activity and the other is natural background. This section is an attempt to highlight how land uses in southwestern coastal areas have changed in different time periods with different factors.

20.3.1 Land Use Changes Before Independence to Early Stage of Independence (in 1971)

In the time period before independence (in 1971) of Bangladesh, southwestern coastal land had been used mainly for paddy cultivation and partially for traditional shrimp farming. Local landlords constructed small dykes or embankments around individual land to limit saline water overflow and prevent crop damage since the seventeenth century. This traditional mechanism of construction of embankments through local efforts practically ceased in 1947 (Islam 2006b).

Embankments had deteriorated due to the lack of proper maintenance in the 1950s–1960s. As a result, salinity intrusion and tidal flooding prevented developing paddy cultivation. Since the government recognized the necessity of producing more rice for the increasing population and protecting coastal areas for crop production, the Coastal Embankment Project (CEP) was established in 1967 with the World Bank's assistance. The Dutch term "polder" was introduced for protecting the designated areas against tidal floods, salinity intrusion, and sedimentation. The areas were surrounded by dykes or embankments and separated from the main river system. The gross polder area was 1.01 million ha by June 1971 (Talukder 1991), and the Bangladesh Water Development Board (BWDB) developed multipurpose flood control, drainage, and irrigation projects. As a result, crops were saved from salinity and flooding; some yields increased by 200–300 % (Nishat 1988). The dominant land use during this period was traditional local paddy cultivation. Modern paddy varieties were also introduced. Bangladesh Agricultural Development Corporation (BADC) introduced modern irrigation equipment, chemical fertilizers, pesticides, and high-yielding varieties developed by international and national research institutes. This introduction made ready to accept Green Revolution, which uses chemical fertilizer, pesticides, and irrigation water mainly to increase in wheat, rice, and corn yields all over the countries in the late twentieth century. Other land uses remained the same: salt production, mangrove forest, and traditional shrimp farming (Islam 2006b; Ahmed 2011).

20.3.2 Land Use Changes in the 1970s–1980s

The World Bank and other donors helped to promote large-scale polderization for meeting the increasing demand of agricultural production during the period of 1970s–1980s. In addition, the Green Revolution, which began in 1960s for increasing agricultural products with seed-fertilize-water technology, had been promoted especially after the independence in 1971. As a result, changes in land use occurred because of the intensification of paddy cultivation with the attempted expansion of modern varieties and conversion of agricultural and to nonagricultural use (Sereno 1981). In addition, because of polderization, this area has been experiencing severe drainage congestion and waterlogging since the early 1980s. The rivers of the southwestern region in Bangladesh are characterized by active deposition of sediment causing significant reduction in their drainage capacity. Besides, construction of costal polders that de-linked the floodplains from the rivers and diminished upstream flow during the dry season deteriorated the sedimentation problem in this region (IWM 2007). Around the same time, demand on shrimp had been increased and the price for shrimp was becoming higher on the international market. Polders provided an opportunity for intensive shrimp farming. Salt water was willingly allowed entry in the areas surrounded by polder to raise shrimp. Land previously used for agriculture and mangroves was transformed, often forcibly, to shrimp farming (Islam 2006b). As a result, wide-scale land use conflict was created.

20.3.3 Land Use Change by Government and Community Interventions After the 1990s

Drainage congestion and waterlogging since the early 1980s were still severe issues in the 1990s. Southwestern coastal Bangladesh experienced drainage congestion inside and heavy siltation outside the polders because of extensive polderization of the hydrodynamically active delta, and subsequently the achievements from polderization gradually evaporated (Islam 2006b). To solve these long-standing problems, the Khulna-Jessore Drainage Rehabilitation Project (KJDRP) was implemented during 1994–2002 (IWM 2007). However, local people did not accept the structural solutions. A community-focused participatory approach was adopted in June 1995, and the traditional Tidal River Management (TRM) project was adopted by local people. In addition, greening of the coastal belt tree plantation is encouraged in coastal villages. Coastal embankments are being planted and leased to poor settlers in exchange for routine maintenance of the embankments. Plantations on newly accreted mud flats help in stabilizing the land, which can later on be settled by victims of erosion elsewhere. These adopted management measures do not only contribute to forestry resource management but also to the social, environmental, and economic well-being of the coastal communities. These efforts are at present being integrated into an Integrated Coastal Zone Management (ICZM) project (Iftekhar and Islam 2004). The government has promulgated the Land Use Policy (2001), Tsunami Vulnerability Map (2005), Coastal Zone Policy (2005), and Coastal Development Strategy (2006) (Islam 2006a) in order to achieve efficient management of coastal land and natural resources and to preserve and enhance critical ecosystems and ecological processes (MoWR 2005).

20.3.4 Land Use Change in Southwestern Coastal Area by Natural Disasters

A scholar claims that natural disasters may affect land use (Dale 1997). In fact, in the coastal areas, climate and water-related disasters such as floods, cyclone, storm surges, and tsunamis may cause inundation and intrusion of saline water in vast areas, and eventually these areas become uninhabitable for a long time. Consequently, these disasters induce intensive changes in land use, life, and livelihoods (UN-HABITAT 2010). Southwestern coastal areas of Bangladesh (a large part of Satkhira, Khulna, and Bagerhat districts) had experienced such massive changes since the 1960s to the present decade. It is observed that both frequency and severity of cyclones and storm surges are increasing in this coastal belt (Fig. 20.4).

Since coastal area was hit by number of cyclones in the 1960s, at that time it started to be realized that protecting coastal area is needed. During that time, coastal afforestation started with the objective of protection from cyclones and foreshore erosion. Mangrove wetlands act as a barrier against cyclones, avoid coastal erosion,

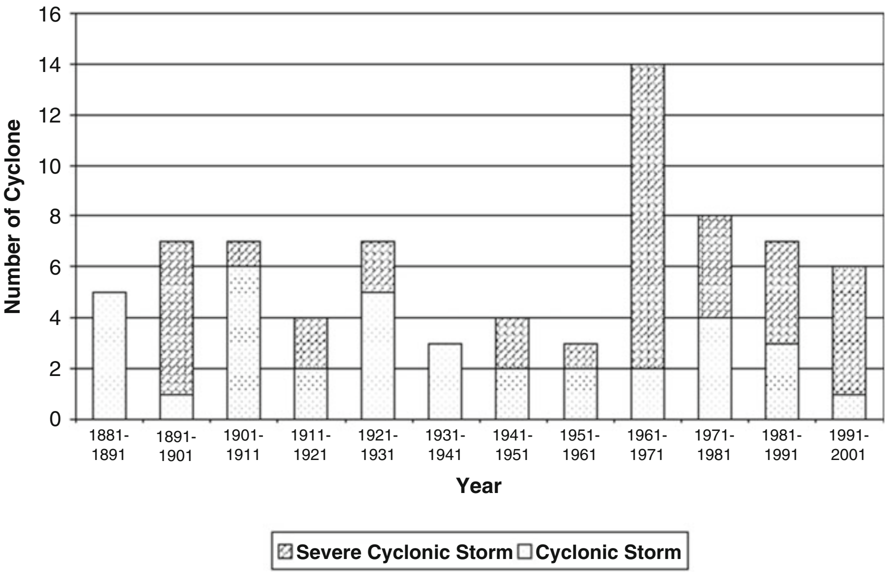

Fig. 20.4 Number of cyclonic storms that landed on Bangladesh (Kabir et al. 2002)

and provide nursery grounds for a number of commercially important fish, prawns, and crabs (Islam 2006b). Another measure is National Cyclone Program (NCP), which was formulated by the Government of Bangladesh in 1986. It focuses on the improvement of the coastal embankments, protection of newly accreted lands, development of forests, improvement of infrastructure and coastal transport, and provision of cheaper cyclone shelters. While the study and design for NCP were in progress, the cyclone of 1987 and 1991 struck the coast and caused extensive damage and great loss of life.

The coastal area was continuously hit by severe cyclones in the 1990s–2000s. The catastrophic cyclone of April 29, 1991 affected a large construction project including 21 coastal polders. The Bangladesh Coastal Embankment Rehabilitation Project (CERP) was initiated in response to the devastating cyclone of 1987 and 1991, which started in June 1996 and ended in June 2003. The overall project objective was to improve security of life, property, crops, and livestock along the cyclone-prone coastal areas. Cyclone Sidr (November 2007), a 10-year return period cyclone, and Cyclone Aila (May 2009) provide recent examples of devastating storm surge in Bangladesh (EMDAT-CRED). Both of these cyclones posed extensive loss and damages in lives and livelihood and caused long-term inundation and salinity intrusion in vast areas, which is still presenting the evidences of massive changes in land uses and lives of southwestern coastal communities.

20.4 Land Use Changes in Southwestern Coastal Bangladesh: Consequences to Food and Water Supply

Though land-man ratio is very low in Bangladesh, it is estimated to be 0.06 hectares (ha) per person (FAO 2013); land is the key role player in all means of livelihood in rural and coastal communities of Bangladesh. This low level per capita land is shifting from agricultural land to nonagricultural use in an alarming rate of about 1 % per year (Planning Commission, 2009, cited in SRDI 2013). In addition to this shifting of land use, agricultural lands in coastal areas are getting inundated with saline waters due to cyclone associated with high tidal surges and tidal flood. Rabbani et al. (2013b) reported that the recent cyclones (Sidr and Aila) accompanied by storm surge and increased salinity intrusion into freshwater and soils are the most catastrophic phenomena for southwestern coastal zone, and these affected rice production and drinking water availability. A number of studies have already explored such negative impact on crop production and water availability in the southwestern coastal areas due to land uses change (Karim 2006; Basar 2012; Rabbani et al. 2013a, b; Khan et al. 2015).

Since the last four decades among different issues and changes in southwestern coastal areas of Bangladesh, land use change along with natural disaster is considered as the most evident and distressing driver of changes. The most severe and largest change is the shift to “gher” farming from agriculture production. Local term “gher” means the systems of brackish water aquaculture production (Shameem et al. 2014). Along with the local people’s perception, scholars studies recognized that this massive changes in land use have direct impacts on coastal land and water ecosystems, including agro-ecosystems and environment (Sohel and Ullah 2012; Paul and Vogl 2011). Further, scholars argue that this coastal zone of Bangladesh is extremely vulnerable to a number of rapid and slow onset events that affect rice production and related livelihoods (Rabbani et al. 2013a).

Recent study conducted by Shameem et al. (2014) has identified following impacts of land use change (agriculture and mangrove forest to brackish water aquaculture) on coastal environment and ecosystem:

- Degradation of Sundarbans mangrove forest
- Decline in wild shrimp population (due to overharvesting)
- Loss of fish and non-fish aquatic biodiversity (resulting from damaging shrimp-fry bycatch)
- Spread of diseases and parasites in shrimp farm potentially linked to introduction of exotic farmed shrimp species
- Disruption of natural environment of wild species
- Genetic degradation associated with escapes of cultured and exotic species
- Water pollution caused by discharge of wastewater from shrimp farm
- Salinization of groundwater and soil

All these listed impacts of land use change are directly and indirectly threatening agricultural production and food supply. Especially, salinization of water and soil has the most severe impact on agricultural production and water supply in southwestern coastal areas. Different studies conducted in Bagerhat and Satkhira districts denote these impacts on crop production, vegetation, and livestock.

20.4.1 Consequence to Agricultural Production and Food Supply

A study conducted by Rahman et al. (2013a) clearly noticed that cropland is decreased due to increases in shrimp culture. Due to these changes in land use, the yield of the *aman* rice crop declined quickly. Rabbani's study (2013a, b) in Shyamnagar Upazila (one of the most vulnerable subdistricts in southwestern coastal zone), claims that 71 % of cultivated areas in upazila (subdistricts) are affected by high level of salinity (above 12 days/m, here ds/m means decisiemens per meter, which is a unit of salinity measurement). Rice production data collected from Shyamnagar Upazila Agriculture Office (2012) also denotes that in different parts of the upazila *aman* (main rice crop), production has substantially decreased by 31 % and 15 % in 2009 and 2010, respectively (UAO 2012). Cyclone Aila in May 2009 is recognized as the main reason behind this decrease. Further, according to BBS, the net cultivated area in the southwestern coastal district Satkhira decreased by about 7 % from 1996 to 2008 (BBS, 2008, cited in Rabbani et al. 2013a)). Different studies claim that cyclones Sidr and Aila in 2007 and 2009, respectively, were the principal factors behind inundation of land, waterlogging, and salinity intrusion in southwestern coastal areas (Basar 2012; Rabbani et al. 2013b; Rasel et al. 2013; Khan et al. 2015). During cyclones Sidr and Aila, seawater was driven into ponds and rivers in Khulna, Bagerhat, and Satkhira districts in southern Bangladesh, and therefore, in some districts salinity in wells is now ten times higher than the tolerable limit for rice cultivation. This situation poses a grave threat to both food and drinking water security in southern Bangladesh (Rasel et al. 2013). In this time period, rice production dramatically declines, and in some upazilas there was no rice production at all due to salinity. This decline in rice production and crop failure trigger overall loss of income among the families dependent on agriculture. Rabbani et al. (2013b) reported that about 82 % of the households had to face a severe food crisis more than ten times in last 10 years.

Southwestern coastal area is facing not only the decline in rice production but also the decline in production of vegetable, livestock, and poultry. Rahman et al. (2013b) and Karim (2006) have explored that anthropogenic activities and natural disasters are the main causes of overall decrease in the land coverage by vegetation. It is found that from 1975 to 1985, vegetable cultivation was seriously affected, and in 1999 the cultivation of major vegetables declined drastically in southwestern costal upazilas (Karim 2006). Most of the local tree species have become threatened and affected by various land use change (Rahman et al. 2013b; Karim 2006).

Salinity intrusion due to the presence of shrimp farms is another reason for destruction of trees, as the forest is cleared to cultivate shrimp (Haque et al. 2008).

Karim (2006) studied in southwestern coastal district Bagerhat and noticed a sharp decline in the production of livestock and poultry due to rapid expansion of shrimp farms in that locality. The rate of decrease in livestock and poultry production from 1985 to 1999 was nearly double than that of 1975–1985. Further, in these coastal areas, production of wheat, jute, and sugarcane has been affected seriously, and now it is almost impossible to grow these crops because of soil salinization. According to the Salinity Survey Report 2010 of Bangladesh, about 2.13 million acres of cultivated land is affected by soil salinity in varying degrees, accounting for 70 % of the total cultivable area in the coastal and offshore regions (SRDI 2010). This salinity is being thought to be a silent poison in the southwestern part of Bangladesh due to continuous shrimp cultivation (Kabir and Iva 2014).

Following section denotes the consequences of land use change to agricultural production and food supply. As a case study it illustrates the picture of Horikhali village, which is one of the most land transformed village.

20.4.2 Case 1: Horikhali Village of Paikgacha Upazila of Khulna District

Due to salinity intrusion, shrimp farming became popular in this study area since the early 1990s. Rapid and uncontrolled conversion of agricultural land (paddy field) into shrimp farm has changed the total agricultural practice of Horikhali village of Paikgacha Upazila. Now except a few homestead gardens, there is almost no agricultural practice in the village. Before starting massive shrimp farming in the Horikhali village, generally 15–18 mond (1 mond = 37.1 kg) paddy is produced in 33 decimal (1 Bigha) land. But now if any farmer tries to produce rice, the production decreased about three times than before. General people who are not shrimp farm owners want to cultivate shrimp with paddy in the *gher*.

Homestead garden is a rare picture in Horikhali village (Fig. 20.6a), and livestock can hardly be seen, as there is no grazing field or almost no paddy field. All parts of the village shrimp farms are the most common. Figure 20.5a, b is showing a shrimp farm in dry season and shrimp farm in normal season. Green beauty of Bangladeshi villages is fully absent in this village. There are almost no plants and trees except a few which are highly salinity tolerant. Poor people claim that about 15 years before, they could grow at least some crops and vegetables in their small amount of lands and that contributed much to their dietary requirements. But now as they are not able to produce anything due to salinity, they need to buy all kinds of food and vegetables, which is sometimes really hard for them with their limited income.

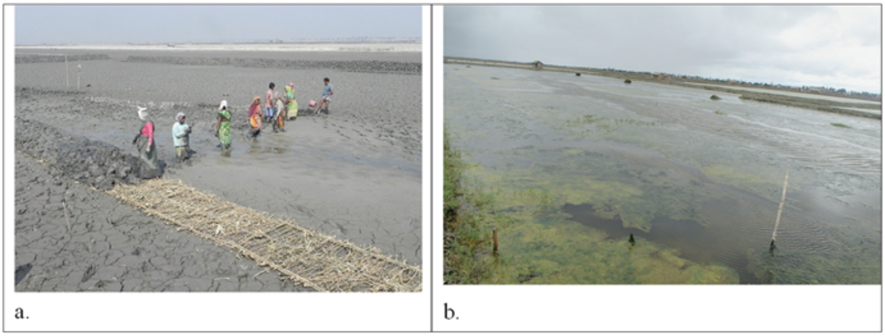

Fig. 20.5 Shrimp Farms in Horikhali village, Paikgacha Upazila, Khulna. (**a**) Shrimp farm preparation in dry season. (**b**) Shrimp farm in normal season

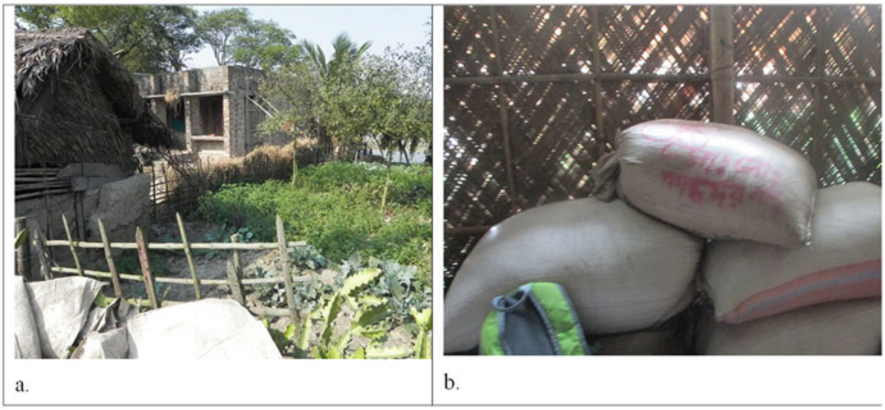

Fig. 20.6 Realities in southwestern coastal villages. (**a**) Homestead garden, a rare picture in Horikhali village. (**b**) Rice, as salary of day labor, earning from outside the coastal districts

Since rice production has been declined remarkably in southwestern coastal zone, agricultural day laborers are trying to manage their staple food by adapting different mechanisms. One of the adaptation mechanisms is seasonal migration to the central parts of the country during harvesting time. Generally in April–May and in December–January, a group of agricultural laborers go to Gopalganj, Madaripur, Faridpur, and such other districts that are relatively close to southwestern coastal areas. These migrated laborers work in the paddy fields and receive paddy as their salary and bring back that paddy to home for partial fulfillment of their whole year rice need. Generally in a season a person can earn 7–10 mond (1 mond = 37.1 kg) paddy by this job in other districts (Fig. 20.5b).

Table 20.3 Water area (ha) in the coastal zone in 2002–2003

District	Beels	Semi-closed seasonal water bodies	Baor	Ponds
Total CZ	5448	1655	1752	115,959
Bangladesh	114,161	50,711	5488	290,500
%	5	3	32	40

Source: DoF 2003, cited in Islam (2006a)

20.4.3 Consequence to Water Sector

In coastal region, pond aquaculture and shrimp farming occupies the main land use because of the presence a vast network of river systems, beels (natural depressions), baors (dead river sections), flood lands, and ponds that provide opportunities for both capture and culture fisheries. Table 20.3 shows the water area coverage in coastal zone. From this table, it has been seen that about 115,959 ha of land is used for pond aquaculture that represents 40 % of the total pond area of Bangladesh. Likewise, baor (dead river sections) occur in the southwestern districts of Jessore, Khulna, Narail, Satkhira, and Gopalganj that also covers 32 % of the total baor area of the country.

A good tidal range, conducive temperature regimes, and productive water and soil conditions made the shrimp farming a viable livelihood option for coastal people (Nuruzzaman 2006). Furthermore, Ali (2006) and Rahman et al. (2011) mentioned that conversion of traditional paddy culture land to shrimp culture ponds is a well-established practice that also contributes to the land use change in coastal Bangladesh. Swapan and Gavin (2011) found that shrimp cultivation had changed almost 90 % of the land, which had been converted from agricultural uses and mangroves into shrimp farms in the southwestern part of Bangladesh. Massive introduction of this shrimp aquaculture by land use change is considered as severe threats to local ecological systems, such as deterioration of soil and water quality, depletion of mangrove forest, decrease of local variety of rice and fish, saline water intrusion in groundwater, local water pollution, and change of local hydrology (Kabir and Iva 2014).

Due to the land cover changes by shrimp farming and natural disaster, salinization is the most acute problem in southwestern coastal areas. Both surface and groundwater are filthy with acute and high salinity intrusion along with arsenic-contaminated groundwater and drought (Abedin and Shaw 2013). Therefore, the coastal region, in particular southwestern areas, suffers from a serious safe drinking water crisis (Akber 2010). It is reported by Ahmed (2008) that about six million people are deprived of safe drinking water in southwest region. Since the southwestern region is located in the coast, deep groundwater in the coastal area, this area is relatively vulnerable to the contamination of saline water intrusion, which makes groundwater unsuitable for drinking or irrigation (Kim et al. 2006). As a result, the scarcity of safe drinking water bounds people to drink contaminated water that leads to diarrhea and various waterborne diseases such as cholera. Moreover, the presence of high level of salinity in drinking water might cause an increased rate of preeclampsia and gestational hypertension in pregnant women (Khan et al. 2011). Adding together, a report by SRTT (2011) mentioned that salinity in drinking water causes kidney diseases like kidney stone and rheumatism. The report further stated that the salinity has negative impacts on domestic cattle in terms of deterioration of the milk productivity and reproductive health. Besides, to supply safe water, women and adolescent girls have to fetch water from far drinking water sources. In some areas, neighborhood water sources are all affected by high salinity, so they must travel long distances on foot every day to find and procure drinking water. Sometimes to get a bucket of water from a water tank and pond sand filter (PSF) provided by the government or NGOs, one has to wait several hours and travel a long way to fetch it (Ahmed et al. 2007; Rabbani et al. 2013b).

20.5 Conclusion

Being a popular country in the world, the high density has a significant influence on land use or land cover in Bangladesh. The dense population results in a high human to land ratio of about 520 people per square kilometer (BBS 2012). Since there is an acute shortage of land in Bangladesh, therefore, the many diverse uses of limited land have created conflict. Further, frequent natural disasters like floods, cyclone, tidal surges, river erosion along with long-term inundation, and salinity intrusion are restricting efficient use of this scarce land, especially in coastal areas. Conflicting and inefficient land uses influence on the agricultural system and socioeconomic condition of the country. In terms of coastal land, it has been observed that salinity along with natural disasters is the pressing cause of land use changes and eventually it is accelerating food and water shortages. According to Habiba et al. (2013), this situation in coastal areas has been evolved due to both climatic as well as anthropogenic factors such as sea level rise, increase of natural disasters like cyclone and tidal flooding, reduced dry season flow in the Gorai River, faulty management of the coastal polders, excessive use of groundwater, and the presence of Farakka barrage. All these climatic and anthropogenic factors not only encourage shrimp farming and restrict rice cultivation but also affect income and activities negatively, creating safe water crisis and decreasing employment (Khan et al. 2015). Likewise, sea level rise will worsen coastal erosion. In some coastal areas, a 30-cm rise in sea level can result in 45 m of landward retreat (Rabbani et al. 2010a, b). In the southern region of Bangladesh, it is projected that a 65-cm sea level rise by 2080s will result in loss of 40 % of the productive land (Rahman and Rahman 2015).

From this study, it is evident that land use changes in the southwestern coastal areas through human activity as well as natural background such as geology, topography and climate, and climate-induced natural disasters. According to a scholar (Islam 2006a), natural disasters have made coastal land use management an important aspect in national development. Therefore, coastal land use management is considered as one of the key features in national coastal development policy and strategy. Taking into account, coastal planning and land use management have received serious attention by the Government of Bangladesh. The government has approved and adopted Land Use Policy (2001), Coastal Zone Policy (2005), Tsunami Vulnerability Map (2005), and Coastal Development Strategy (CDS) (2006). The Coastal Zone Policy provides a policy framework for long-term ICZM (MoWR 2005). The Coastal Zone Policy 2005 states that "actions shall be initiated to develop land use planning as an instrument of control of unplanned and indiscriminate use of land resources" and "zoning regulations would be formulated and enforced in due course." On the other hand, nine strategic priorities and three routes of implementation have been adopted in the CDS document. One of the nine priorities is "Optimizing the use of coastal land." All these initiatives have created a high expectation among coastal communities, NGOs, and government agencies working in the coastal zone. However, there remain gaps and conflicts among different ministries and agencies involved in coastal zone management (Islam 2006a). A total of seven ministries named Land, Agriculture, Environment and Forest, Water Resources, Local Government and Rural Development, Fisheries and Livestock, and Communications and Shipping are involved in the administration and management of coastal land. Due to lack of integration and coordination and presence of conflicting interests among different ministries, coastal development initiatives are sluggish. Further, it is claimed that the National Adaptation Program of Action (NAPA), which is the unique policy paper of Bangladesh government to fight against climate change, does not clarify the role of shrimp farming in coastal land use transformation. Basar (2012) also pointed that water salinity issue so far did not get much importance in the government's disaster management policy. However, along with different policy, planning, and strategies, the Comprehensive Disaster Management Program (CDMP) and Tidal River Management Project of the government are few of the noticeable government initiatives to manage the food and water crisis of coastal communities. In order to resolve water crisis, government and NGOs have made some water storage tanks and installed pond sand filter (PSF) in different parts of southwestern coastal areas. But those do not cover all their needs and some are out of order due to lack of maintenance. In addition to the different interventions, land zoning has been identified as an important instrument for sustainable land management for decades. Nonetheless its implementation still remains a concern. Therefore, it is urgent to establish a network of expert groups on coastal and land use planning and management. In addition, it needs technical support to establish a modern GIS-based land record system.

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Part V
River Issues in Land Use

Chapter 21
Flood Disaster Mitigation Measures Through Land Use Management in the UK and France

Yasushi Yoshida and Michiko Banba

Abstract The policy of land use management for natural disaster mitigation has been shared globally as an increased number of natural disasters have occurred. Among them a set of unique systems have been established in England. The characteristics of the English systems are found in their quantitative risk assessment, flexible and process-oriented planning permission, and comprehensive land use control combined with regulations, insurance, risk information disclosure, and indirect intervention by the central government. On the other hand, another unique set of systems in this field have been established and in operation in France for more than 30 years. The characteristics of the French systems are found in its qualitative risk assessment, disaster-prevention-specific planning system independent of the standard city planning system, regulation by practical zoning harmonized with actual land use, and comprehensive land use control combined with different policy instruments and direct intervention by the central government. It is still evolving putting more emphasis on ex ante disaster prevention measures. Although neither the UK nor France has achieved perfect forms of land use management for flood disaster mitigation, every possible policy instrument is employed in their own unique way, and the best management system is being pursued by trial and error.

Keywords Land use management • Risk information disclosure • PPS25 • NPPF • Flood map • Flood insurance • PPR • CatNat

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21.1 Introduction

The importance of disaster mitigation[1] measures through land use management has been shared globally as an increased number of natural disasters have occurred, which are attributed to global warming. Among these measures that have been implemented in different countries, there are a number of remarkable ones. By paying close attention to the historical conditions and the social background behind those measures, they can give other countries valuable insights for considering their own disaster mitigation measures. This chapter introduces an overview of such mitigation measures implemented in the United Kingdom (UK)[2] and France, while analyzing and comparing each other.

Around the world, diverse types of flood disaster mitigation measures have been implemented. In addition to land use regulation, which is one representative approach, they include disclosure of risk information and insurance systems. Although land use regulation for natural disaster mitigation is simple and clear as an idea, its application to the real world typically faces a very high hurdle. Although land use regulation has such difficulty being implemented alone, it can be executed more smoothly by being combined with other policy instruments. The UK and France have successfully implemented it by combining different policy instruments comprehensively; thus, the two countries serve as excellent examples by comparing and discussing significant features of each. In the UK, the Environment Agency provides citizens with flood risk information via the Internet. Based on this information, land use control for flood disaster mitigation is implemented using the standard city planning scheme, and flood insurance is provided by private insurance companies. There is a close collaborative relationship between the UK government and the insurance industry, and they have been continuously pursuing the optimum role-sharing by trial and error (22.2). On the other hand, France has a special planning system dedicated for natural disaster mitigation, which is called the PPR (Plan de prévention des risques naturels prévisibles). The PPR, which was formulated by the state government, is being operated in combination with the natural disaster insurance system, CatNat (Catastrophes Naturelles). The CatNat is a public insurance system supported by the state government and is connected with PPRs in the country's legal system. The CatNat system has been continuously reformed to put more importance on efforts for pre-disaster mitigation than on the post-disaster compensation (22.3).

In Sects. 21.2 and 21.3, we analyze these countries' land use management for natural disaster prevention and then summarize them in Sect. 21.4. In this chapter, the output of the interviews conducted in 2008 in England and France is used. The outline of interviews is explained at the end of the chapter.

[1] In this chapter, the term "disaster mitigation" is used in a wide sense including disaster prevention.

[2] In this chapter, the description of the UK systems is focused on England since the English systems are the typical ones in the UK. Quite similar systems have been established and operated in other areas.

21.2 Overview of the UK's Land Use Control for Flood Disaster Mitigation and Insurance System

In England, about 10 % of all properties are located on the floodplain, and 11 % of all new homes have been built in flood hazard areas since 2000. In such a context, a policy report issued for the UK government pointed out the necessity of strong planning control (Pitt 2008, ch. 1 p. 61). In addition, in the summer of 2007, a major flood occurred in the central part of the country. This flood has been called the largest emergency event in peacetime since World War II (Pitt 2008, forward). The amount of insurance money paid out due to this event reached 3 billion pounds, which is the most expensive payout ever for a natural disaster that has occurred in the UK. It is with this experience that the UK has developed its own unique policies on land use management. One of the major characteristics of the land use management policies is that the risk assessment, which is at the basis of the system, is implemented based on objective quantitative data. In addition, the policy's characteristics include that the Environment Agency operates the risk assessment system and provides the risk information in a highly integrated manner in cooperation with the state government and private companies. We will summarize below the land use regulation for flood disaster mitigation, the disclosure of flood risk information, and the flood insurance in the UK's system.

21.2.1 Land Use Regulation for Flood Prevention in the City Planning Process

In the UK, the system of land use regulation for flood prevention was established in 2001 in a policy document called the Planning Policy Guidance 25 (PPG25). Then, the Planning Policy Statement 25 (PPS25) was developed by amending the PPG25 in December 2006 (DCLG 2006), and its practice guide (DCLG 2008) was published in July 2008. They had served as effective guidelines in this field until recently with minor revisions in 2010 and 2009, respectively. However, since the change of government from labor to conservative in 2010, the country's city planning administration was largely streamlined,[3] and policy documents were streamlined accordingly. As a result, current effective basic policies are documented in the National Planning Policy Framework (NPPF) (DCLG 2012a) and its technical guidance (DCLG 2012b). As the NPPF only stipulates the general policy direction, it is important to

[3] The preamble of NPPF states, "In part, people have been put off from getting involved because planning policy itself has become so elaborate and forbidding – the preserve of specialists, rather than people in communities. This National Planning Policy Framework changes that. By replacing over 1,000 pages of national policy with around 50, written simply and clearly, we are allowing people and communities back into planning" (DCLG 2012a, Ministerial foreword).

Table 21.1 Zoning regarding flood

Flood zone	Annual probability of flooding
1	<1 in 1000 (<0.1 %) from river or sea flooding
2	Between 1 in 1000 (0.1 %) and 1 in 100 (1 %) for river flooding or between 1 in 1000 (0.1 %) and 1 in 200 (0.5 %) for flooding from the sea
3a	>1 in 100 (>1 %) for river flooding and >1 in 200 (>0.5 %) for flooding from the sea
3b	Functional floodplain (see paragraphs 4.87–4.95)

Note: These flood zones refer to the probability of river and sea flooding. Ignoring the presence of defenses
Source: DCLG (2009), p. 42

review the NPPF's technical guidance as well in order to understand the country's land use control for flood disaster mitigation.[4]

21.2.1.1 Land Zoning and the Environment Agency's Flood Map

In the UK, land use control for flood disaster mitigation is conducted within the framework of the regular city planning process. The DCLG, which is in charge of city planning, has released the NPPF and its technical guidance to facilitate the local planning authorities (LPAs, municipal authorities in charge of city planning) to develop their city plans. In these documents, the land which is subject to city planning is classified into four different zones (zones 1, 2, 3a, and 3b) based mainly on the probability of floods (DCLG 2012b), pp. 3–5) (Table 21.1).

In addition, the Environment Agency has developed and published a nationwide flood map, in which zones 1, 2, and 3s are shown in white, pale blue, and blue, respectively. Figure 21.1 shows a part of the flood map of Central London. The areas along the Thames River, which is serpentine, are colored pale blue and blue, whereas land protected by banks is shown with hatched lines.

On the other hand, in the NPPF guidance, land usage is classified based on the vulnerabilities against flood risks as shown in Table 21.2 (DCLG 2012b, pp. 6–7). Furthermore, Table 21.3 shows the permitted land use for each zone in a matrix, based on the zoning and flood vulnerability classification shown above. Zone 1, which is white colored, is free from land use regulation, and the regulations become gradually stricter when moving from zone 2 to zone 3a and finally to zone 3b. In zone 3b, a functional floodplain, almost all land use should be avoided (DCLG 2012b, pp. 8).

[4]This guidance also states that it "retains key elements of PPS25" and that "the retention of this guidance is an interim measure pending a wider review of guidance to support planning policy" (DCLG 2012b, p. 2). As the planning policy documents have been largely streamlined and the planning system is still in a transition period, it will also be useful to refer to the PPS 25 as needed, which has been already formally abolished.

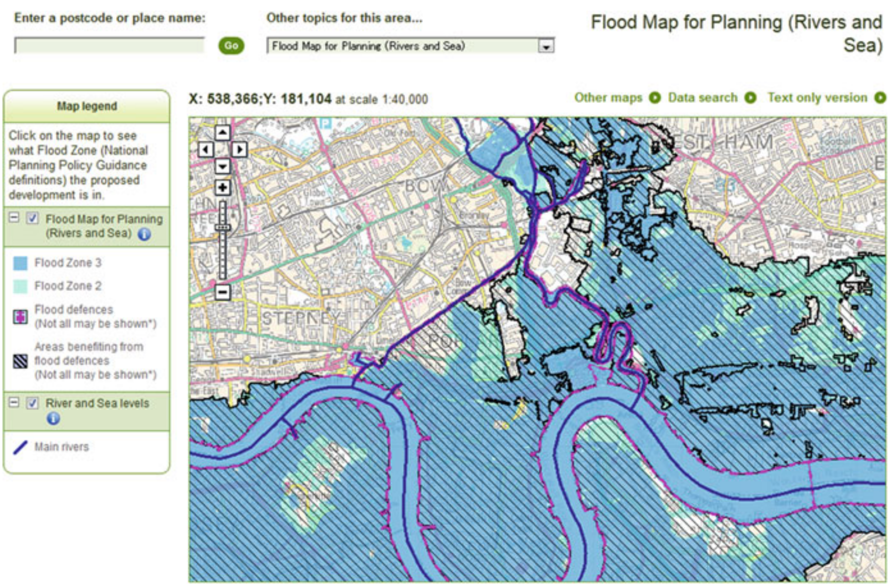


Fig. 21.1 A part of the UK's flood map (Source: webpage of the Environmental Agency)

Table 21.2 Flood risk vulnerability classification (NPPF guidance)

Essential infrastructure	Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk
	Essential utility infrastructure which has to be located in a flood risk area.
Water-compatible development	Flood control infrastructure
	Shipyard ore marina, etc.
	Recreation and open space, etc.
Highly vulnerable	Police stations, ambulance stations, and fire stations
	Emergency dispersal points
	Underground living space
More vulnerable	Hospitals
	Residential institutions such as residential care homes, children's homes, social service homes, prisons, and hostels
	Buildings used for dwelling houses, student halls of residence, drinking establishments, night clubs and hotels, etc.
Less vulnerable	Police, ambulance, and fire stations which are not required to be operational during flooding
	Buildings used for shops, financial professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, nonresidential institutions not included in "more vulnerable," assembly and leisure, etc.

Source: DCLG (2012b), pp. 6–7. Simplified by the authors

Table 21.3 Flood risk vulnerability and flood zone “compatibility” (NPPF guidance)

Flood risk vulnerability classification		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood zone	Zone 1	✔	✔	✔	✔	✔
	Zone 2	✔	✔	Exception test required	✔	✔
	Zone 3a	Exception test required	✔	×	Exception test required	✔
	Zone 3b Functional floodplain	Exception test required	✔	×	×	×

Source: DCLG (2012b), p. 8
Key: ✔ Development is appropriate
× Development should not be permitted

21.2.1.2 Procedure for Planning Application

When developing city plans, the LPAs must adhere to the national policies described in the NPPF and its guidance. In addition, the permission of individual planning applications for development must be implemented according to the policies in the city plan. Thus, the specific development is controlled by the national policies, through the city plan formulation and the individual permissions for development. On the other hand, if there are substantial reasons to be considered apart from the content of the city plan, it is permitted for the LPAs to take them into account.[5] Therefore, each planning application is not completely controlled by the language of the policy documents. The LPA may impose certain conditions on the applicants when granting them permission (ODPM 2005, 20), while the developers are also allowed to negotiate with the LPAs in return for undertaking some obligations.[6]

What is unique here is the process called “sequential approach.” In this approach, when a planning application is filed in zone 3 land, for example, it is first determined whether it is possible to implement the development plan in zone 1 or zone 2, which are both safer than zone 3. If the plan could be implemented in zone 1 or 2, implementation in zone 3 is not permitted (PPS25 16–20).[7] Furthermore, a stan-

[5] They are called “material considerations.” The general principles of the planning system by the government stipulates that, “Local planning authorities may sometimes decide to grant planning permission for development which departs from a Development Plan if other material considerations indicate that it should proceed” (ODPM 2005, 16).

[6] The Town and Country Planning Act 1990, Section 106, and ODPM (2005), 22

[7] As different from planners who establish the development plan, developers do not necessarily have many alternative lands for their developments. Therefore, the sequential approach seems to be an extremely severe policy for them. When one of the authors asked the DCLG officer about this point in the interview in 2008, he answered, “Some developers might say so, but avoidance of flood risk is necessary. How to obtain lands for development is a matter of business risk in relation to the process for getting permission. We recommend developers to consult with the local planning authority from the early stage. Development process is partnership working” (Interview (3)).

dard for an "exception test" must be applied. Even if it is concluded that a development application cannot be implemented in alternative zones by the sequential approach, the application will earn permission to be implemented in the originally intended site only when the application passes the exception test. This exception test states, in short, that even if it is a dangerous area, when the necessity of the development is observed from a broader view with the concept of sustainable development (when the benefit of the sustainable development is larger than the risk associated with the development), permission is given (PPS25 19. D.9). In the end, development applications filed for zones 2 or 3 ("dangerous zones") can be permitted if: (1) the development cannot be implemented in a safer area and (2) the benefits from the development exceed the risk associated with the development. Here is room for the LPAs to use great discretion.

21.2.1.3 Flood Risk Assessment

When submitting development applications for the dangerous zones, developers must conduct a "flood risk assessment" to demonstrate that the development meets the requirements of the sequential approach and the exception test (PPS25 E8–E10). This risk assessment is referred to as site-specific flood risk assessment (FRA). Prior to an FRA, which is conducted by the developer, a strategic flood risk assessment (SFRA) is performed at the municipal level by the LPAs (DCLG 2012b, pp. 8–9). The SFRA specifies a standard for the LPAs' assessment of planning applications (both the assessment process and the resultant report are referred to as "SFRA").

The Environment Agency's flood maps only consider floods from rivers and those from the sea such as a high tide. It does not take into account the impact from inland waters nor the effectiveness of flood prevention facilities. As such, the LPAs conduct land zoning by themselves based on the Environment Agency's flood map while also taking into account local information regarding inland waters and flood prevention facilities. The resultant zoning is shown in a map included in their SFRAs. The actual land use regulation for flood disaster mitigation is performed based on the SFRA map, not on the Environment Agency's flood map. Therefore, in some cases, there are differences between the zoning specified by the Environment Agency's flood map and the zoning specified by the SFRA, which is used for the actual regulation. The differences stem from the risk assessment of the inland waters and the safety effectiveness of flood prevention facilities (Interview (3)). In other words, each local governmental body makes its own map to serve as basis for regulation by customizing the information provided by the Environment Agency (Fig. 21.2). However, when the LPAs develop the SFRAs, they must consult with the Environment Agency (DCLG 2012b, p. 8).[8] This rule allows the Environment

[8] "Sheffield City modifies the zoning in the EA flood map through discussion with EA and a consulting company in the process of implementing SFRA. For example, in Meadowhall district, part of the area colored in dark blue in the EA flood map is downgraded as zone 2 (purple) in the SFRA

Fig. 21.2 The Environment Agency's flood map (*left*) and the map of the city of Sheffield included in a SFRA (*right*) (Source: PRILIT 2011, pp. 93–94)

Agency to prevent the local authority from changing the existing zoning boundaries too permissively, especially when a local authority has a strong tendency to promote development. According to Interview (3), "without the nation's strong policy, LPAs are affected by local political pressures. This is why Environment Agency intervenes in local land use control."

21.2.1.4 The Environment Agency's Opinion and the Call-In by the Secretary of State

If the LPA is going to grant a planning permission intended for an area in the dangerous zones, the authority must officially notify the Environment Agency (Fig. 21.3). Then, if the Environment Agency disagrees with granting the permission, the three parties (the LPA, the Environment Agency, and the applicants) must confer about this plan. In this consultation, the three parties seek a reasonable compromise by understanding each other's concerns and in some cases making some changes or adding some conditions to the plan, as needed.

However, if the trilateral dialogue does not reach an agreement and the LPA still desires to grant the permission, against the advice of the Environment Agency, the LPA must officially notify the secretary of state in charge of the city planning. Then the secretary of state can "call-in."[9] The call-in system is one in which the state government can intervene in the decision-making of local governments regarding the development of city plans and individual planning permissions, and the state government may work in place of the local government if the state government finds it necessary to do so. When a call-in is selected, the LPA loses its permission author-

map. This is due to the fact that the effects of levy which are not considered in the EA flood map are considered in the SFRA (PRILIT (2011), pp. 92–93).

[9] According to the amendment of planning system in January 2007, the Town and Country Planning (General Development Procedure) Order 1995, Art. 10; the Town and Country Planning (Flooding) (England) Direction 2007; DCLG Circular 04/2006, December 2006; and PPS25 26–28

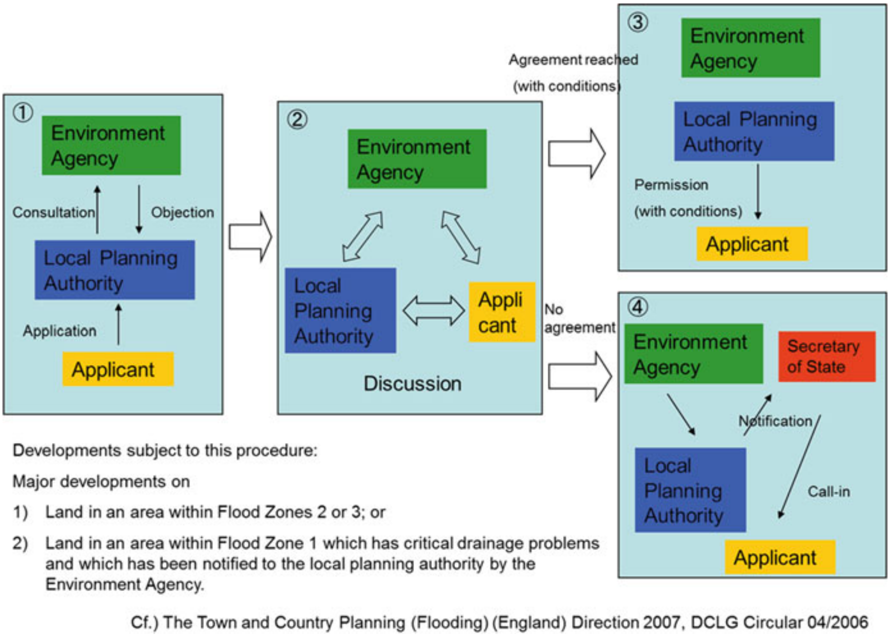


Fig. 21.3 The Environment Agency's opinion and the city planning secretary of states' call-in

ity regarding the concerned matter, and it will be handled by the state government including granting permission or rejecting an application.

However, the call-in system, which demonstrates the state government's strong authority, only has been applied in some exceptional cases such as when the applications are against the major national policy.[10] Almost all of the applications have been granted or withdrawn as a result of the consultation among the concerned parties. According to a DCLG officer, the call-in system had only been used four times between the system's introduction into the flood land use control in January 2007 and the date of the interview, November 2008 (Interview (3)).

21.2.1.5 Summary

As discussed above, the UK's development control in the flood risk zones is much more flexible than the image created by the words of "land use regulation." However, the UK government has well-developed assessment procedures, which include a requirement to developers to conduct a risk assessment, sequential approach,

[10] "The Secretary of State expects to use his power of direction and intervention sparingly." "In general the Secretary of State will use these intervention powers selectively and will not interfere with the jurisdiction of local planning authorities unless it is necessary to do so" (ODPM (2005), 25–26).

exception test, and consultation among stakeholders. In this land use regulation system, it is intended to combine flexible control and well-developed procedures. In our Interview (3), the author asked the question "How much effective is the UK's land use regulation for the "prevention" of development in the dangerous zones?" The response was that this regulation's goal is not to "prevent" but to "control" and "mitigate" (Interview (3)). As demonstrated by this answer, the UK does not aim to simply suppress development but to adjust the land use and mitigate potential damages.

In this system, the leading players are the LPAs. One of the major features of this country's system is the flexibility of having the decision which is sought by stakeholders based on the judgment on the ground and taking advantage of the authority's discretion. On the other hand, even though the state government has a strong policy instrument with the call-in system, it generally plays an indirect role such as establishing national policies.

21.2.2 Disclosure of Risk Information

21.2.2.1 Flood Map

Information disclosure is an important mechanism, which not only functions by itself to improve the society's ability to prevent disaster but it also supports the land use control for flood disaster mitigation from its very foundation, as described below.

The Environment Agency publishes the nationwide flood map on its official website. This map is used not only by the citizens to understand the flood risk that their residential area faces in order to develop better evacuation and disaster mitigation plans but also by the LPAs to implement the city planning regulation through local customization of the agency's flood map. Furthermore, as mentioned below, it is used by private insurance companies as basic information for their risk assessments when they are underwriting insurance. This map can be accessed by anyone, without any charge. Users can check an area-specific level of flood risk by inserting the area's name or its postal code on the Environment Agency's webpage. The flood map is updated every 3 months. When a flood occurs, the flood map will be updated with the actual flood data at the next scheduled update (EA 2006, p. 7).

As seen with the information disclosure system, the UK does not seek perfection but they try to quickly provide the best information possible. For example, the PPS25 repeatedly points out the increased flood risks due to the global warming (PPS25 2, 7), whereas it also states that the Environment Agency's flood map does not sufficiently reflect the potential increase of the future risk.[11]

[11] Flood map—your questions answered Q13 http://apps.environment-agency.gov.uk/wiyby/31662.aspx

On the agency's website, the frequently asked questions (FAQ) regarding the flood map are also available. In these FAQs, the agency states that if someone does not agree with the map's classification of his/her land as being in a dangerous zone, he/she can send a request to the Environment Agency to make a change in the map. However, when submitting the request, the landowner must have some scientific evidence, not just anecdotal evidence.[12] As demonstrated in this answer, in the UK, risk information is not given in a unilateral way by an authority, but is published, verified, and maintained in communications between the authority and the residents, who are the consumers of the risk information. This is not just a "polite face" but an actually functional system, in which many individuals have actually submitted such requests and achieved a number of corrections in the flood map (Interview (1)).[13] Such a government stance is remarkable from the perspective of enhancing the effectiveness of land use control. The PPS25 clearly indicates the role of each stakeholder related to flood control, including the residents' responsibilities. For example, the PPS25 states that "there is no general statutory duty on the Government to protect land or property against flooding (PPS25 21)" and that "landowners have the primary responsibility for safeguarding their land and other property against natural hazards such as flooding (PPS25 22)." To seek the sharing of responsibilities among the stakeholders, disclosing risk information and ensuring interactivity have crucial importance.[14]

21.2.2.2 Recent Development

In response to the development of the EU Floods Directive, a system reform was conducted in the UK, resulting in new advancement in disclosure of flood risk information. The EU's directive on flood risk assessment issued in 2007[15] requires the EU member countries to assess flood risk, designate flood risk areas, and create their flood hazard maps and flood risk maps. Furthermore, in the future, the member countries must develop flood risk management plans based on these maps. Accordingly, the UK has passed national laws to implement these tasks, and works

[12] Flood map—your questions answered Q21. The same page as above.

[13] Some private consulting companies advertise that they have all expertise and experience needed to challenge and, in some cases, correct the Environment Agency's flood maps, should there be any doubt as to the flood zone allocation of a particular site. The system could be understood that it utilizes a specialized knowledge of the private sector to effectively evaluate flood risks in the society. As risk evaluation can never be perfect, it is reasonable to limit the costs shared by the taxpayers in general to achieve a certain level of accuracy and put excess costs on the developers or the landowners who need more accurate risk evaluation.

[14] Those statements are not seen in the present NPPF and technical guidance. It is not probably because there was a policy change regarding this part but because the policy makers thought it was unnecessary any more to stipulate what had been a matter of course in simplifying planning policy documents.

[15] Directive 2007/60/EC of the European Parliament and the Council of 23 October 2007 on the assessment and management of flood risks

Fig. 21.4 The published webpage provides access for each flood map (Source: The Environment Agency's webpage)

according to the Flood Risk Regulations[16] have been advanced. Emanating from the EU's legislation, the UK's work on the development of flood hazard maps and flood risk maps advanced under the coordination between the Environment Agency and local governments. On December 12, 2013, the Environment Agency released its new flood maps on its website[17] (Fig. 21.4). This newly released flood maps are composed of four different ones:

1. Flood map for planning (rivers and the sea)
2. Risk of flooding from surface water
3. Risk of flooding from reservoirs
4. Risk of flooding from rivers and the sea

Among these four maps, map (1) is a conventional flood map of the country. Map (2), which was published for the first time, shows the risk of floods caused by fallen rainwater that does not drain away or penetrate into the soil. On this map, the probability of this kind of flood is indicated in four levels (high, medium, low, and very low). By clicking any point on the map, it provides not only the probability of flooding but also the projected water depth and flow rates. Map (3) shows the impact of a collapse of reservoirs (25,000 m^3 or more), whereas map (4) is intended for use in risk assessment for flood insurance. See the next section for more details about the last map.

21.2.3 Flood Insurance

Flood insurance not only gives relief to affected people but it also serves as a useful measure to ensure the effectiveness of land use control for flood disaster mitigation. Generally, when considering insurance as an economic system, flood insurance is

[16] Statutory Instrument 2009 No. 3042, Environment Protection, the Flood Risk Regulations 2009
[17] http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e

expected to induce insured persons to take actions for disaster mitigation by setting the premium rates based on the risks. For example, in an area that faces an extremely high risk of floods, land use is expected to be suppressed by the prohibitively high premium rates. The UK pursues this function of insurance from its aspect as an economic system.[18]

21.2.3.1 Basic Mechanism of Flood Insurance in the UK

First, a prominent feature of the UK's flood insurance is that it is provided as a part of the basic coverage of private insurance companies' residential insurance products,[19] and there is no public flood insurance provided directly by the government. Whether or not a resident has flood insurance is fully optional. As the flood insurance is provided by private insurance companies, there is no uniform content in the insurance policies. There are also no uniform methods for premium rate setting across the insurance industry. Typically, the premiums are decided based on the location's flood risk, as well as the structure, size, and age of the building. When assessing the flood risk, insurance companies use their own flood data in addition to the flood data provided by the Environment Agency[20] and private data analysis companies.

Because the UK's flood insurance is provided by private companies, there is no public financial support from the government for premiums. Furthermore, there have not been any reinsurance or insurance premium pool systems operated by the state government or the whole industry. However, currently, the insurance industry is advancing the establishment of a pool system called "Flood Re" as described below.

21.2.3.2 Provision of Risk Information for Insurance Assessment

As described above, the previous flood map was provided under the name of "flood map," which only considered floods from major rivers and the sea and did not take into account the impact from inland waters or the existence of flood prevention facilities. Although the flood map's main intended application was land use control, it was also used as essential information for setting flood insurance premiums. When a viewer clicked at any point on the map, it showed the assessed risk of the point considering the existence and the effectiveness of the flood prevention

[18] For some basic ideas about insurance and land use management, see Appendix at the end of this chapter.

[19] The coverage of flood insurance in England is more than 90 %. It is unique as commercial-based flood insurance system without government assistance (ABI 2007a, p. 6). Flood risk is included in the standardized property insurance together with other risks such as fire and burglary risks.

[20] "The risk of flooding from rivers and the sea map and data is available to insurers, under licence, who may use it alongside other information to inform their decision" (EA n.d., p. 3).

facilities in three levels (high, medium, and low). After the EU's Floods Directive was issued (DEFRA 2009, p. 6), the map was enhanced in December 2013, and this risk information is now shown on an independent map titled "Risk of Flooding from Rivers and the Sea," on which the degree of risk is shown by four levels (high, medium, low, and very low). Private insurance companies individually set their premium rates based on the risk information shown on this map after adding the results of the individual building's risk assessment to it. As such, although the land use control for flood disaster mitigation is not directly linked to the flood insurance system as a legal institution, they both indirectly interact via the information provided by the public organization and risk assessment conducted by private companies.[21]

21.2.3.3 Linkage Between Flood Insurance and Land Use Control (Alerts for Developers)

Collaboration between the government and the insurance industry is not just in the provision of information. Guidance issued from the Association of British Insurers (ABI) states, "It is highly unlikely that insurance (and consequently mortgages) would be advanced for developments that proceed against EA advice, except at a level that could make them unaffordable to households" (ABI 2003, 17). On the other hand, regarding such a stance by the insurance industry, the UK government raised awareness among developers in stating that "The Association of British Insurers and the Council of Mortgage Lenders will comment on individual proposals on which the Environment Agency objects and where there appears to be a high risk. Those proposing development, especially speculative investment, are advised to consult ABI guidance…" (PPS25 H12).[22] Through such an interaction between the government and the ABI, developers who are going to implement reckless development plans have been warned. As described below, in France, developers who do not comply with the land use controls are excluded from semipublic insurance in a systematic manner, whereas the similar effect occurs in the UK in an indirect manner. According to an officer, this measure has produced a highly strong effect (Interview (3)).

[21] Although it is important to know how much difference actually exists between the highest and the lowest premiums in this system in order to infer mitigation effects of flood insurance's premiums, the data were available neither at the ABI nor at the DEFRA. (Interviews (1) and (2)).

[22] Those alerts appear neither in the NPPF nor in its technical guidance. It is probably because of the simplification of the planning policy documents not because of any policy changes.

21.2.3.4 Collaboration Between the Government and Private Companies (The Partnership Approach)

Although the UK pursues the position of flood insurance as an economic system, if this position is pursued without any restrictions, a concern develops that socially disadvantaged residents, who typically live in areas with high risks, will be excluded from the insurance system. To avoid such a situation, it is necessary that the insurance industry has a certain collaborative relationship with the state government. Such a partnership is represented by the ABI's "Statement of Principles on the Provision of Flood Insurance" ("Statement of Principles") (ABI 2005). This statement presents the content of the agreement achieved by close discussions between the ABI and the government, which was published as the ABI's statement. In this statement, the ABI commits that insurers will maintain flood coverage for domestic properties and small businesses in areas where the flood risk has a 1.3 % annual probability (or 1 in 75 years) or less and will use their best efforts to continue to provide coverage for areas where flood risk has a greater than 1.3 % annual probability. In return, the government promises that it will provide a series of measures to minimize the number of buildings that is excluded from insurance coverage, including continuing investment in flood control, reforming the land use planning system, and providing high-quality flood risk information.

To date, several amendments have been added to this statement since its initial release. The relationship between both parties had a turning point after the major flooding in 2007. Those major floods left the insurance companies with huge losses, resulting in increased discontent against insufficient information and the small investment in flood control provided by the government (ABI 2007b). In such a context, there were repeated heated discussions with industry executives and the minister in charge of flood insurance (Interviews (1) and (2)). The outcome of the discussions was that an updated statement would be released in August 2008 (ABI 2008). This statement was based on the content of the previous statement but it only covered buildings built by the end of 2008; thus, those built after January 2009 were not covered.

21.2.3.5 Movement of System Reform (Introduction of "Flood Re")

After the expiration date of the statement was extended to June 30, 2013, the government and the ABI had continuous consultations on what the succession plan should be. The major issue in the consultations was how the high-risk properties should be treated. The number of such properties was said to reach about 200,000 (ABI 2012), which accounted for 1–2 % of all of the residential insurance underwritten by insurance companies in the UK, and the remaining 98 % were able to be covered by insurance without any problem (DEFRA 2014, p. 1). In fact, from the beginning, there was a strong opposition to the statement; as one critic claimed that it applies low premiums to those who are normally supposed to pay high premiums with a consideration on social context, which makes the insurance market lopsided.

Furthermore, another critic pointed out that the statement caused unfair competition in the market because they were applied only to the existing insurance companies, not to new entrants.

Because of these concerns, various discussions were held between the government and the insurance industry, finally resulting in the signing of a memorandum of understanding (MOU) between them on June 27, 2013. In this MOU, the ABI proposed establishing a new flood reinsurance system called "Flood Re," and the government agreed that they would have negotiations about the establishment of the system. The primary points of the MOU are:

- The "Flood Re" will be established as a nonprofit fund to ensure insurance coverage for high-risk houses. The fund's resources will be provided by insurance companies.
- Each insurance company will transfer the flood risk portion of the already underwritten high-risk insurance into the Flood Re. The upper limit for the premiums for the homeowners will be set based on the real estate tax assessment (council tax band).
- Each insurance company will contribute 180 million pounds annually to the Flood Re. This amount of money would be equal to a premium of 10.5 lb per insured person. It would also be equal to the amount of the internal grants from the currently existing low-risk group to the high-risk group (ABI's website[23]).

Based on these agreements, the legislative work for the Flood Re was started. The bill containing the Flood Re provision was called "the Water Bill," which sets the burden of insured persons as shown in Table 21.4.[24] By setting an upper limit on the flood insurance premiums based on the asset value of the properties, the Flood Re system tries to balance between an economic aspect (utilization of market principles) and a social aspect of flood insurance.

The Water Bill was enacted in May 2014 and will be effective in the summer of 2015.

21.2.3.6 Assessment of UK's Insurance System

When assessing the UK's flood insurance system, various viewpoints can be taken. In terms of the coverage rate of the flood insurance, the country's insurance system is unique among the world's commercially based flood insurance because, as

[23] https://www.abi.org.uk/News/News-releases/2013/06/ABI-and-Government-agree-Memorandum-of-Understanding-on-scheme-to-safeguard-UK-flood-insurance

[24] The maximum insurance fees for households with high risk are shown in the top row of the table. In England, households are divided into eight groups from A to H according to their asset values for the purpose of imposing a property tax (council tax). Group A is a household with assets of less than 40,000 lb, while group H is a household with assets over 320,000 lb. Utilizing this evaluation for the property tax, flood insurance fees are rate-capped according to their asset values (DEFRA 2013, p. 2).

Table 21.4 Prediction of the premium burden for high-risk households

Council tax band	A	B	C	D	E	F	G	H
Maximum price for flood component of policy via Flood Re	£210	£210	£246	276£	£330	£408	£540	No cap/not eligible
Typical price for other insurance components (fire, theft, etc.)	£180	£180	£186	£204	£222	£252	£390	
Insurer overheads and profit	£260	£260	£288	£320	£368	£440	£620	
Typical overall price charged to policyholder	£650	£650	£720	£800	£920	£1100	£1550	
Compared to what might be charged without Flood Re	£1140	£1165	£1185	£1290	£1430	£1560	£1950	

Source: DEFRA (2013), p. 2

measured by the ABI, it covers over 90 % of the country's households even though it does not receive any public financial support (ABI 2007a, p. 6).

In addition, it is remarkable that the UK's flood insurance with a focus on the economic function is designed so that it promotes the citizens' disaster mitigation awareness and action by setting premiums according to the risk that they face. In this light, it should be noted that the UK successfully suppresses the building of irresponsible development by ensuring some linkage between flood insurance and city planning. Another major feature of the UK's flood insurance system is that although it puts great emphasis on the function of insurance as an economic system, it has also developed a "partnership approach" between the government and the insurance industry in order to avoid an excessive emphasis on the economic aspect. Regarding this feature, a report submitted to the government (the Pitt Review) stated that it did not believe that there was a need to change the current system of providing flood insurance, and supported the Statement of Principles (Pitt (2008), p. 144), even after the major 2007 flooding caused huge losses for the insurance companies. However, more recently, the country has been forced to review the system based on the statement. As discussed, the best balance between the opposite positions (one that focuses on the economic function of an insurance system and another that focuses on its social function) is still being pursued in the UK.

21.2.4 Summary: Features of the UK's System

21.2.4.1 Quantitative Risk Assessment

In the UK, risk assessment is the basis for land use management for flood disaster mitigation. The major feature of this risk assessment is in its objectivity using quantitative data. The Environment Agency, the concerned governmental authority, operates a risk assessment system providing flood risk information in a highly integrated manner in cooperation with the government and the private sector. The UK's system seems efficient and reasonable in that (1) the Environment Agency openly publishes the flooding risks that it has assessed with a certain level of reliability while correcting them when someone successfully demonstrates the existence of an error and that (2) the private insurance companies can perform a more detailed assessment in order to set their insurance premiums using the agency's basic risk assessment according to their needs.

21.2.4.2 Realistic and Flexible Land Use Control in City Planning, in Which Discretion Is Used

A general feature of the UK's city planning system is that a considerable amount of discretion is granted to the local authorities, and this feature applies to the land use control for flood disaster mitigation as well. Some detailed features derived from this point are (a) a "flexible structure" in which an application is examined by a flexible review process which includes the sequential approach, the exception test, and the conditional permission, not by a uniform application of fixed standard or regulation; (b) a "stance which places importance on the consultation procedure" in which appropriate decisions are sought through negotiations among concerned stakeholders such as the development applicants, the LPAs, and the Environment Agency; and (c) a "realistic regulation mechanism" that makes final decisions on land use by comparing the risks and benefits while considering the existing land use and the necessity of new development.

21.2.4.3 Disaster Mitigation Measures Taking Advantage of the Economic Functions of Flood Insurance

In the UK, while coordinating with land use control, every insurance contract assesses the flood risk of each property and accordingly sets the premium rates based on the risk. As a result, the contractor's disaster mitigation efforts are expected to be encouraged by economic incentives. On the other hand, the government and the insurance industry work collaboratively to ensure that an excessive focus on the economic aspect does not have undesirable consequences such as the exclusion of the socially disadvantaged from insurance. Based on this collaboration, they pursue a desirable future flood insurance system.

21.2.4.4 Comprehensive Policy Instruments

Another major feature of the UK system is that the country seeks to achieve its goal not only through regulation but also through various policy instruments, such as the disclosure of risk information and the insurance system. Furthermore, as seen in the current “Statement of Principles,” the government is committed to investing in flood control, whereas it requires the insurance companies to underwrite a certain amount of properties with higher risk at lower premiums. Although the policy instruments have not been legally connected like those in the French system (described below), the UK has developed a system in which different instruments informally connected so that they work well along with the aim of disaster mitigation.

21.2.4.5 Indirect Control by the State Government

Another major feature of the UK’s system is that the state government indirectly controls each stakeholder. The state government basically limits its own function to the formulation of basic policies and the provision of risk information while leaving the details up to the local governments and the residents’ own decisions, as well as utilizing the functions of the insurance market. In the background of the state’s indirect intervention, each stakeholder’s responsibilities is clarified, and an emphasis is put on individual responsibility.

21.3 Overview of the Land Use Control for Natural Disaster Mitigation and Natural Disaster Insurance in France

In France, efforts on natural disaster mitigation have been made for a long time. From the policy perspective, current land use control for natural disaster mitigation has its origin in the PER (Plan d’exposition aux risques naturels), a planning system which was formulated in 1982. Originally the 1982 Act was proposed as a compensation measure for damage from natural disasters. However, during the law-making process, the compensation system developed into a natural disaster insurance (CatNat), and the land use control was institutionalized into the PER. In actuality, the planning work advanced so slowly that the system was reformed in 1995, driven by the severe flooding which hit Niems in the 1990s. Accordingly, the new PPR (Plan de prévention des risques naturels prévisibles) was established by law in 1995. Then, along with the EU’s movement to formulate the Floods Directive and the repeated occurrences of natural disasters, the system experienced many reforms and resulted in today’s unique system.

The major feature of the risk assessment on natural disasters in France is that it is a qualitative assessment. This is based on lessons from the past experience. Today, risk assessment in the PPR is conducted based on "common sense" (bon sense) according to the "precautionary principle" which allows uncertainty to some extent. As for the French natural disaster insurance, since premiums are not set based on the risk each property faces, the insurance companies do not conduct risk assessments. However, as described below, in the recent movements to reform, there is an increased possibility that the premiums will be set based on risk, though only in a very limited manner.

21.3.1 Land Use Control for Natural Disaster Mitigation Based on PPR

The heart of French land use control for natural disaster mitigation is the PPR, which is primarily formulated by the department governor (préfet), who serves as part of a national organization,[25] in collaboration with concerned municipalities. This is a planning system exclusively for disaster mitigation, which is separate from the normal city planning system.[26] The covered disasters are predictable ones, such as flooding,[27] landslides (including subsidences), avalanches, wildfires, earthquakes, eruptions, rainstorms, and cyclones (CE L562-1).[28]

21.3.1.1 The Current Status on the Development of PPRs in France

The current status of the development of PPRs in France is shown in Fig. 21.5 and Table 21.5 (as of April 2008). In France, there are about 37,000 municipalities, which are called "communes." Among them, 23,170 are faced with natural disaster risks and 6390 have established their officially authorized PPRs. This number reaches 12,436 when including communes with PPRs which are effectively operating but not yet officially authorized ("immediate applications" as described below), communes which are in the process of drafting PPRs and communes with PPSs

[25] The department (département) which counts 96 in the mainland France was originally a national administrative unit whose governor (préfet) was, and still is, appointed by the national government. While the department is strengthening its character as the local government with the parliamentary speaker as its head since the reform implemented by a law to facilitate decentralization in 1982, the development of PPR is a task of the governor as a national government unit.

[26] The responsible body for developing normal city planning is the commune, the municipal government (CU L123-6).

[27] Although different kinds of natural disasters are covered by this system, flooding is the typical case as the historical background as well as Table 21.5 shows. Explanations below, therefore, are mainly focused on flooding. In France, 20 to 25 % of municipalities are located in the floodplain and two million people live there (Fiselier and Oosterberg 2004, p. 47).

[28] In this chapter, the following abbreviations are used to refer the letters of law. CE, Code de l'environnement (Natural Environment Law) ; CA, Code des assurances (Insurance Law); and CU, Code de l'urbanisme (Planning Law)

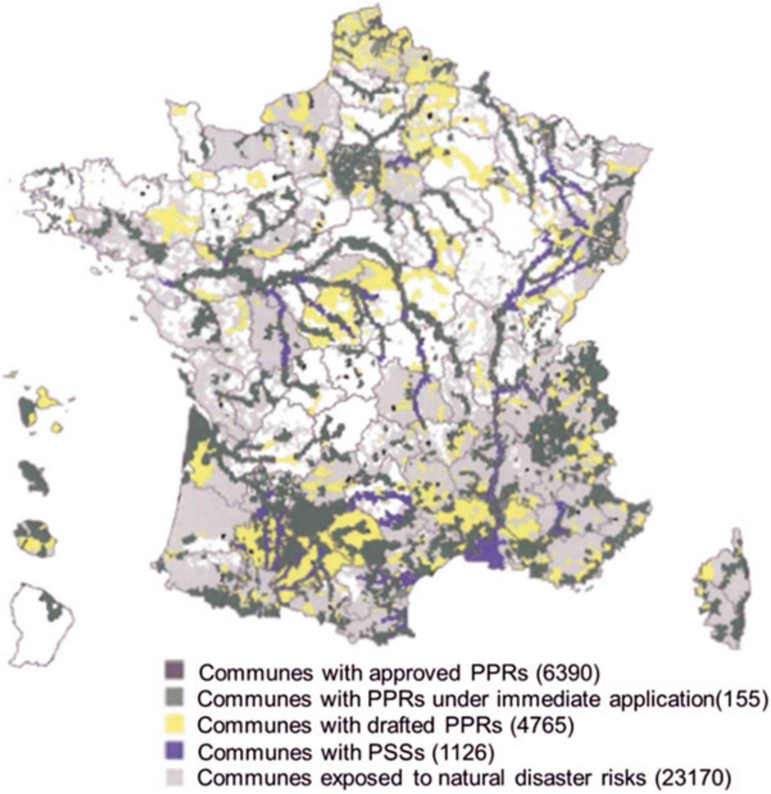


Fig. 21.5 The current status of the development of PPRs across France (Source: MEDAD (Ministère de l'Ecologie, du Dévelopment et de l'Aménagement Durables)

Table 21.5 The current status of development of PPRs by type of natural disaster

	Flood	Subsidence	Avalanche	Earthquake	Forest fire	Total
Communities with approved	5592	1937	275	255	66	6390
Communities exposed to each natural disaster	17,064	9458	560	–	5963	23,170

Source: MEDAD
1) As of April 2008
2) For "Flood," there are additional 1126 communities which have PSSs, which formulated under old legislation and have the same legal values as the PPR
3) Since the categories in the table are not exhaustive and there are communes that are exposed to more than one type of natural disasters, simple addition of figures does not corresponds to the number shown as "Total"

which were formulated under old legislation and have the same legal effects as the PPR by provision of law. As such, we can say that the PPR is a well-established system in France. The geographical distribution of PPRs varies depending on the type of disasters: communes with PPRs for flooding exist along the major rivers (e.g., Rhone, Loire, and Seine), those with PPRs for avalanches are found in the Alps and Pyrenees, and those with PPRs for earthquakes are found in the Alps, Pyrenees, and overseas territories in the Caribbean. The current status of the development of PPRs by type of natural disaster is shown in Table 21.5.

21.3.1.2 The Structure and Content of a PPR

A PPR is composed of the following three kinds of document (CE R562-3):

1. A report (une note de présentation), which shows the geographic area, the characteristics of natural disasters concerned, and the projected damages
2. Maps (des documents graphiques), which describe the zoning of lands that are subject to the regulations
3. A regulation (un règlement), which explains the prohibition of land use and construction requirements in the regulated areas and precautionary or defensive measures that should be taken by public entities and individuals

The areas with natural disaster risks are classified into either a “dangerous zone” or a “caution zone.”[29] PPRs must show the land zoning in the maps listed above 2 (CE L562-1 II., R562-3). The “dangerous zone” is a zone that is exposed to dangers, in which any type of building is either prohibited from being built or certain conditions will be imposed based on the nature and intensity in the risk. On the other hand, the “caution zone” is a zone that does not directly face risks but has the possibility of facing increased risks or newly generated risks due to construction or other actions. In the “caution zone,” construction or other actions are also prohibited or restricted. In addition to such regulations on land use and construction, PPRs can prescribe precautionary or defensive measures that should be taken by public entities and individuals (e.g., development of disaster prevention plans) or other measures such as construction work for disaster prevention on existing buildings in these zones. Such measures can be mandatory to be taken in a certain fixed period of time up to 5 years (CE L562-1 II., III.).

21.3.1.3 Legal Effects of the Development of a PPR

Governors can order property owners to take the required measures that are specified as mandatory by the PPRs. If the orders are not followed, they can be enforced by the authority at the expense of those responsible, such as the owners of the properties (MATE et METL 1997, p. 48). Those who violate the provisions of PPRs can

[29] These terms are not on the code itself but used here only for a referential purpose.

be subjected to criminal punishment (CE L562-5). In addition, the PPR regulations must be included in the list of "public utility easements (servitude d'utilité publique)" (CU L126-1), which are listed in an appendix of the city plans. Any commune that is going to develop its city plan must respect the public utility easements when making decision on land use. A public utility easement is a restriction on the right to use land for public interest. Although it does not have legal basis in the planning code (code de l'urbanisme), the public easement is required to be appended to local city plans because it relates to land use. If there is a discrepancy between the provisions of the PPR and the developed city plans, the provisions of PPRs prevail.[30]

A major characteristic of a PPR is that its legal effects are linked with the country's natural disaster insurance system (CatNat). Although residents can decide whether or not to have insurance, the insurance companies have the duty to underwrite natural disaster insurance by the law (CA L125-2). However, this duty can be waived in transactions with owners who violate the construction prohibition and permission conditions in the "dangerous zone" and the "caution zone" (CA L125-6). Namely, the implementation of the duties specified by a PPR is indirectly ensured by excluding owners from the insurance system who do not comply with the land use regulations.

Another major feature of the legal effect of a PPR is that it can impose required measures on existing buildings. There are, however, certain restrictions: the amount of the cost of the disaster prevention work on an existing building cannot exceed 10 % of the monetary value of the building (CE L562-1V., R562-5).[31]

21.3.1.4 Procedures for the Development of PPRs

The governor of the department plays a leading role in the procedures for the development of PPRs (Fig. 21.6). The PPR is first drafted by a governor as an arrêté (one form of administrative legislation) and then sent to the mayors of the concerned communes (municipalities), where the arrêté is posted in the commune offices for 1 month. The draft PPR is then the focus of consultations in the commune councils and the comments given in this process are respected (CE R562-2, R562-7). The draft PPR, with the opinions from the councils, then advances to public inquiry procedure conducted by the governor. Finally, the draft that is amended based on the

[30] Refer to the following judicial precedent. T.A.Poitiers, 27 janv. 2005, Cne de la Tremblade et indivision Chaillé, n°0302296. Judicial precedents concerning PPR can be seen in a webpage called "JURISQUES 2012" edited by the MEDAD http://jurisprudence.prim.net/jurisprud2012.html.

[31] According to the PPR guidance of the Ministry of Territorial Government, the preferential objective of PPR is to control new developments. The guidance also says that it is difficult to identify effective measures to control risks of existing buildings and that if those measures are to be implemented, it can be sensitive issues that might draw intense oppositions from citizens. Thus, the regulations against existing buildings should be proportional to the degree of risks (MATE et METL(1997), pp. 42–43).

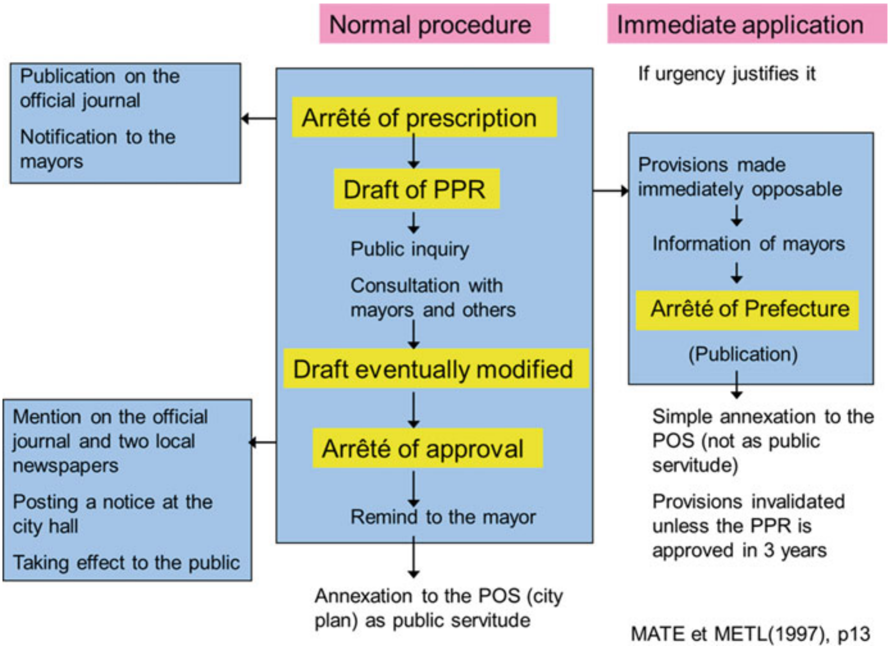


Fig. 21.6 Flow of the development of a PPR

results of the public inquiry is authorized as the governor's official arrêté (CE R562-8, R562-9).

In addition to this normal development procedure, an "immediate application" procedure has been created. This is a procedure that lets a PPR becomes effective provisionally and immediately upon the governor's initiative when there is an urgent need. When the drafted PPR includes provisions about "dangerous zones" and "caution zones," and when it is justified due to an urgency, the governor of the department can immediately enforce the PPR against every public or private entity by an official decision after consulting with the mayors involved. These provisions cease to be opposable when they are not included in the approved PPR (CE L562-2). This procedure was created based on lessons from France's experience. In the past, the PER, which was the predecessor of the PPR, experienced strong resistance from members of local councils, resulting in a great deal of delays in the plan development process.[32] To avoid such a situation again, governors, who serve as a national organ, are granted this strong authority to facilitate the development of a PPR. As of April 2008, a total of 155 communes across the country have the immediate application procedure, which shows that this procedure actually functions as an effectively working mechanism.

[32] The number of developed PER from the year 1982 to 1993 was only 307, which by far fell short of the target number, 2000.

Table 21.6 How to assess the hazards (in case of floods)

Depth	Velocity		
	Weak (storage)	Medium (flow)	Strong (strong flow)
H <0.50 m	Weak	Medium	Strong
0.50 m < H <1 m	Medium	Medium	Strong
1 m < H	Strong	Strong	Strong

Source: MEDAD

21.3.1.5 The Procedure and Principles for Zoning

We will now discuss the procedure and principles for compiling zoning maps. Based on the past experience that the procedure for PER development was too rigid and strict, the PPR's zoning system employs realistic procedures without the necessity of a complicated survey.[33] The basic philosophy of this procedure is the so-called precautionary principle (CE L110-1II1°).[34] Simply put, zoning is executed by the following three steps (MATE et METL 1997, pp. 21–36; MEDD 2001):

(1) Creating a hazard map: Hazard maps are created with the goal of identifying zones that potentially face natural disaster risks and rank these zones based on the hazards that they face. The maps show the predicted hazards by three levels (strong, medium, and weak) based on the types of natural disasters, risk range, and the estimated impact on citizens' lives and properties, which are obtained by field surveys and historical records. The scale sizes of the hazard maps are 1:25,000–1:10,000. For example, in the case of flood, the hazard is defined based on the velocity and depth of the floodwater in a specified area (Table 21.6).
(2) Assessing land use: A qualitative assessment of land use is performed by the following procedures: (a) classifying the land use of concerned areas into non-urban area, urban fringe area, and urban central area; (b) estimating the population who are exposed to dangers; (c) listing existing hospitals, schools, and rescue facilities; and (d) identifying the roads that will be cut off in the case of emergency. As needed, these assessment results are put into a map at a scale of 1:25,000–1:10,000.
(3) Drawing a zoning map: By comparing steps (1) and (2) above, the actual land use regulations are decided (Table 21.7). To do so, a matrix approach is employed. For example, when one zone is assessed as a zone that will receive the greatest hazard in step (1) and if this zone is currently used as a nonurban

[33] The national government attempted to apply standardized format to all the communes without considering differences among them when it tried to establish PERs across France by conducting detailed and expensive surveys. As a result, the process rather created various constraints and conflicts. Thus, the policies of zoning in PPR are announced as follows: flexible methods in considering targeted risks and areas, qualitative rather than quantitative survey, and strengthening of consultation with local stakeholders (MATE et METL 1997, p. 21).

[34] The principle which does not allow the delay of taking effective measures to avoid serious and irredeemable damages just because there is no certainty about the effect considering scientific and technical knowledge at the time.

Table 21.7 Matrix of land use and the intensity of hazards

	Natural zones to preserve	Urbanized areas	
		Other sectors	Urban centers
The greatest hazard	Ban	Ban	Ban or under conditions
Other hazards	Ban	Ban or under conditions	Under conditions

Source: MEDAD
1) Zones of the greatest hazard: ban of construction
2) Zones of less hazards: conditions of realization

area or an urban fringe area (step 2)), new construction will typically be prohibited, or, if the zone is now used as an urban central area, new construction will be prohibited or conditionally regulated. The results are shown in a cadastral map with a scale of 1:5000.

These are the procedures for the zoning of a PPR. Because a PPR imposes strict regulations on land use, one tends to expect that it requires strict and quantitative evidence. But an actual PPR does not. Based on the past experience of operating the country's previous system (PER), a quantitative survey is understood not to always decrease the uncertainty of a risk assessment. As such, the country carries out zoning based on qualitative evidence and "common sense (bon sens)." The Ministry of Territorial Development's guidelines state that "the qualitative assessment of hazard leaves some uncertainty, but it is typically acceptable. Although quantitative assessment can reduce this uncertainty to some extent, employment of the quantitative assessment comes under consideration only in a case by case manner when its effectiveness for a specific purpose is clearly indicated" (MATE et METL 1997, p. 21). However, these processes are divided into a technical analysis and an administrative analysis; in the former, an objective and neutral assessment is conducted while maintaining as much transparency as possible, and in the latter, the optimal regulations are chosen based on the actual situations (MATE et METL 1997, pp. 21–22).[35]

According to a Ministry of Territorial Development publication, the drafting work of such zoning should be led by the governor in collaboration with local authorities. They should continuously discuss the steps involved from assessing the hazards to proposing the drafted zoning. The publication also states that during this process, the strategies and restrictions on development formulated by the local authorities should be considered as much as possible (MEDAD 2007, p. 3). Perhaps due to this deference to local authorities, a report issued by the OECD pointed out that the original boundaries of lower-risk areas are changed primarily due to pressure from locally elected officials and residents (OECD 2006, p. 35). France's sys-

[35] The pamphlet of the Ministry of Territorial Development says, "the principle of banning construction in the most hazardous zone is strict when it comes to the matter of life and death of people. …It is effective to have a discussion among local stakeholders, councilors and the heads of economic or organizational matters to exempt some areas from applying this principle when the areas are already built-up and in the hazardous area (MEDD 2001)."

tem, in which land zoning is conducted based on qualitative surveys, is considered to contribute to rapid decision-making based on the actual situation of the localities while allowing concerns on the security of the locality's safety. In the UK's land use control for flood disaster mitigation, the zoning of land with risks is basically conducted objectively based on the Environment Agency's data, while in the step of granting permission of individual planning applications, the risks and benefits brought out by the development are compared, and then decided at the discretion of the local city planning authority, in a flexible manner. On the other hand, in France, the zoning is conducted according to the actual situation by incorporating the opinions of the local authorities, while the individual permission is granted in a highly objective and transparent manner. In that regard, there are concerns that there is increased political pressure in the zoning process, which may render the security of localities compromised.

21.3.1.6 Example: PPRI of the Paris Department

The summary of the PPRI (PPR for Inondation (flooding)) that was authorized by the governor of the Department of Paris follows. Initially, the PPRI was approved on July 15, 2003, and the current version is a revision which was authorized on August 19, 2007 (Département de Paris 2007). The coverage of the PPRI is the whole area of the Department of Paris (geographically consistent with the area of the city of Paris). Figure 21.7 shows the zoning in the Paris PPRI, and Table 21.8 shows the overview of the regulations for the zones.

The green zone, which is expected to perform a flood control function in case of flooding, is set at Boulogne in western Paris, in which strict restriction is imposed on land use. The restrictions were able to be imposed because this zone is public land and thus there were no difficult adjustments to limit private rights (Interview (4)). On the other hand, the Seine River is designated as a red zone, which is expected to serve as a flood flow-down function. Accordingly, the usage of the Seine is limited to tourism and transportation by ships. The blue zone and light blue zone are existing urban areas in which the estimated flood depths are 1 m or more and less than 1 m, respectively. In these two zones, the residential use of any area that lies lower than the peak depth of the past floods is restricted. Today, of the entire area of the city of Paris (10,403 ha), 20.6 % (2138 ha) has been zoned with respect to potential flooding (Département de Paris 2007, 1. p. 33).

According to a Department of Paris officer, during the formulation and revision sessions of the PPR, they did not experience any major objections from the department residents, due to their increased awareness against risks. In addition, when developing the PPRs, sufficient adjustments are usually made between the governor and the city planning departments. In the case of PPRI of Paris, the department also did not have any problems in coordinating with city planning work (interview (4)). The content of the PPRI is highly realistic; it does not include particularly strict regulations.

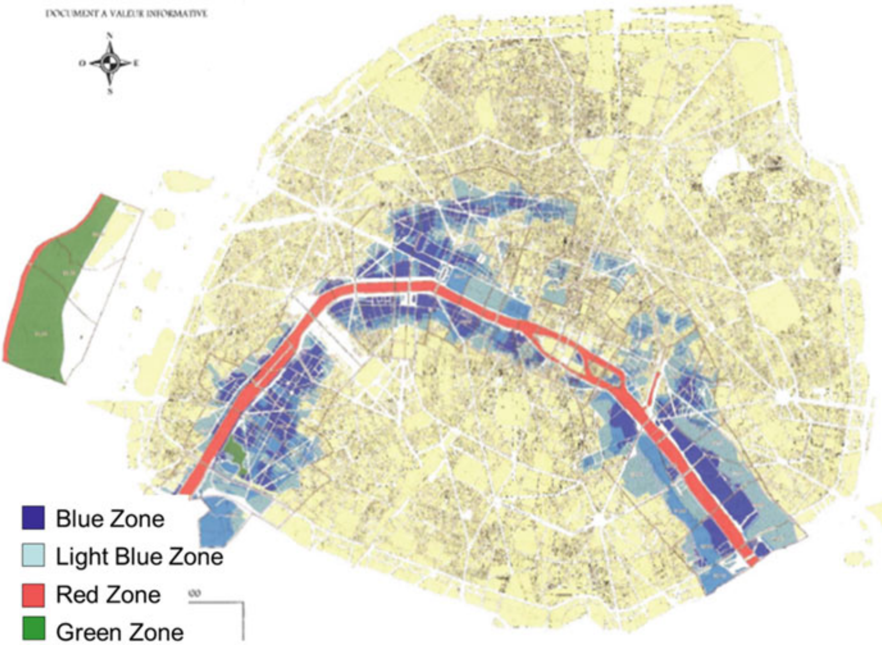


Fig. 21.7 Zoning in the PPRI of the Department of Paris (for legend description, see Table 21.8)

21.3.1.7 Summary

As discussed above, one of the major characteristics of a PPR is that it is formulated and operated directly by the governor, who serves as a national organ. However, how can we justify that such a detailed land use control at a municipal level is performed directly by the state government? According to a Ministry of Territorial Development officer, "it is not only because the governors are familiar with the actual situation of their department and they thus can coordinate closely with the local bodies, but also because the PPR is linked with the nation-wide natural disaster insurance scheme (Interview (6))". As described below, the natural disaster insurance system (CatNat) in this country is ultimately operated with all citizens' burden sharing under the spirit of solidarity (solidarité). Therefore, it is reasonable that the state government manages the level of individual PPRs to ensure that this system is managed appropriately, which in turn ensures the soundness of the insurance scheme. Furthermore, because the land use control for natural disaster mitigation has the potential to cause an economic as well as social decline in the relevant lands, it would be difficult for the local authorities to successfully achieve the desired results on their own initiative. In this context, the French system is well designed in that the state government plays a leading role with striking a balance through realistic zoning that adjusts to the interests in the locality, while stronger

Table 21.8 Overview of regulations for each zone in the PPRI of the Department of Paris

Green zone	All new construction is banned with exceptions of the following cases; constructions connected to existing installations, equipment, activities, or constructions
	The floors of new residence must be above the highest water level known
	All additional paving work is banned unless it is necessary for securing the access of fire engines and ambulances.
Red zone	The following land uses are admitted when they are connected to port activities; exploitation of waterways, touristic activities, and so on; and reconstruction of buildings within some limitation, temporal use in the season of the least risk of flow, and so on
	The usage of boats, barges, pontoons, and floating structures on the flow are admitted
	The changes of use of land situated at a lower level than the highest water level known are admitted only when they are for the purposes of port activities; the exploitation of waterways, touristic activities, as well as artisanal, commercial, or industrial activities; etc.
Blue zone	The vital machinery and equipment in the building such as the water equipment, telephone center, elevators, air conditioning systems, and so on must be protected by a waterproof technic or all other measures of protection
	The counters of water and gas must be installed above the highest water level known unless there are some major technical problems
	All the new construction of residence is banned below the high water level known
	The construction technics and materials that are employed must guarantee a structural resilience of the building during the immersion of several days
	The changes of use of land situated at a lower level than the highest water level known are banned for residence.
Light blue zone	Basically the same as in the blue zone above, although some points of the regulation are relaxed. For example, the restriction on land use change into residence is partly eased in the light blue zone

Source: Département de Paris (2007)
1) This table is a summary by the authors of the regulation shown in the source
2) The "highest water level known" is the water level of the January 1910 flood

powers are granted to the state's PPRs than to the standard city planning, and the powerful procedure of "immediate application" is in place.

21.3.2 *Disclosure of Risk Information*

21.3.2.1 The Right to Know Risk and Residents' Meetings on Disaster Risks

France has a well-developed system regarding natural disaster risk information. First, it is stipulated by law that citizens have a right to information about major disaster risks (CE L125-2). In areas in which PPRs have been developed, the mayors of the communes must provide citizens with disaster-related information, including the characteristics of possible disasters, estimated risks, measures for disaster prevention, the relevant provisions of PPRs, and natural disaster insurance, at least once every 2 years through public meetings with residents or other measures (CE L125-2). In addition, the governors are required to compile and publish a document at the department level explaining the major disaster risks that the department faces (DDRM, Le Dossier Départemental des Risques Majeurs). Then, based on the DDRM, the mayor of each commune in the department must develop a similar document at the commune level (DICRIM, Le Document d'Information Communal sur les Risques Majeurs) and make this document available to be seen freely by citizens at the commune government office (CE R125-11).

Although much effort has been made through such measures to share the disaster risk information among residents, there are criticisms toward the implementation of the policy. A researcher said that "due to the development of the legal scheme in recent years, a great advancement has been achieved at a level of principle. However, there are still challenges in application of the 'rights to risk information' to the citizens' actual life" (Besson 2005, p. 489). Furthermore, the researcher pointed out that the problem with the country's system is that the state government passes down information to local governments, while the local governments believe that they have fulfilled their duties by transferring the information to the public, based on an assumption that each individual will accordingly take proper actions in a self-motivated manner. Moreover, although 15 years passed since the DICRIM system became effective, only about 1000 communes had developed their DICRIMs as of 2004 (Besson 2005, p. 490), whereas there are over 23,000 communes that face the risk of natural disasters in the country. As shown in this fact, in France, the sharing of risk information seems to be a task to be checked off a list.

21.3.2.2 Duty to Disclose in Selling or Leasing Real Estate

One of the most significant features of the French system is the duty to disclose risk information when selling or leasing real estate: in areas that have PPRs that are drafted, officially approved, or under immediate application, real estate owners who are going to sell or lease her/his property are imposed with the duty to provide the following information to the assignee or lessee when entering a contract (CE L125-5, R125-23/27):

(a) A document describing the location of the property, the legal status of the PPR (e.g., already approved, yet to be approved, etc.), and the type of the natural disasters concerned (e.g., floods, earthquakes, and avalanches) (Etat des risques)
(b) A history of past property insurance payments due to natural disasters

The Ministry of Territorial Development has prepared a form for this disclosure process (Fig. 21.8). On the form, the concerned parties must fill out the required items and sign the document. The duty of disclosure is applied to every assignor and lessor regardless of whether or not they are professional real estate agents(CE L125-5). This is a strict provision which directly affects the contractual obligations. In

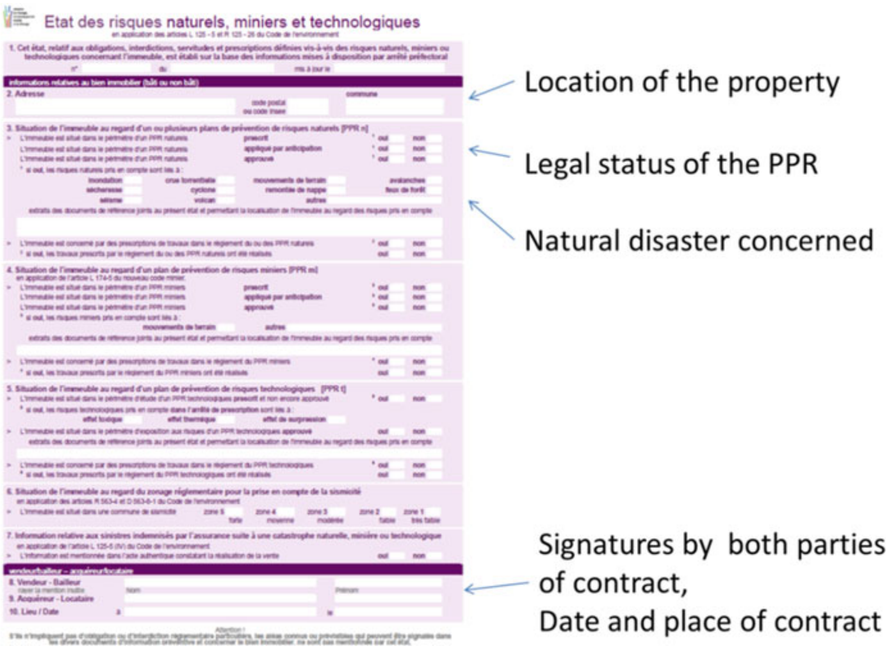


Fig. 21.8 A form for the duty to disclose in selling or leasing real estate (Source: MEDAD)

particular, if the assignor or lessor breaches the duty to disclose, the assignee or lessee can cancel the contract or file a demand for abatement of the transaction price in court (CE L125-5). This system not only increases the public awareness of disaster prevention during each real estate transaction but also is expected to gradually suppress the use of dangerous land through market mechanisms.

21.3.3 Natural Disaster Insurance (CatNat)

21.3.3.1 Fundamental Mechanism of the Insurance System

In France, the insurance for natural disasters is called CatNat (Catastrophes Naturelles) and is provided as part of property insurance products by private insurance companies. The insurance companies have a duty, stipulated by law, to underwrite property insurance in accordance with the insurance conditions set by law. This insurance system is a blend of the private sector with public policy guidance which differs from that of the UK, which is fully provided by the private sector, and also differs from that of the National Flood Insurance in the United States, which is provided by the Federal Emergency Management Agency (FEMA), a government agency. In the French system, citizens, the demand side of insurance, are not

Table 21.9 Trends of the original CatNat premium (Million Euro)

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Premium	1292	1323	1322	1349	1377	1338	1351	1420	1486	1530

Source: FFSA, "Les Assurances de biens et de responsibilité, Donneée clés 2013," p. 27)

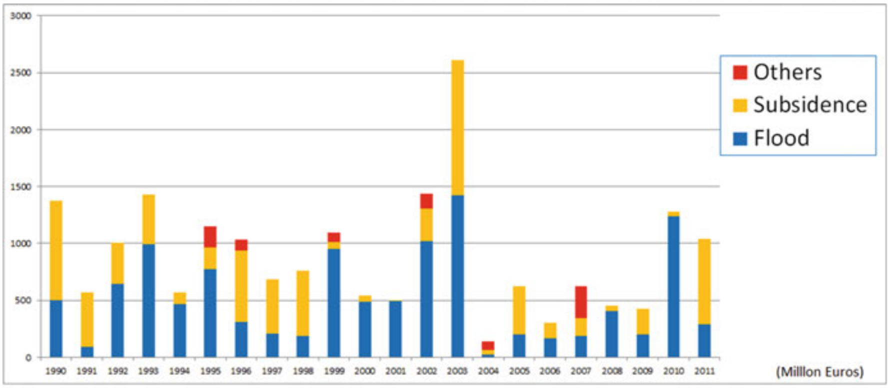
required to have insurance; in this light, it is not mandatory insurance. On the other hand, the insurance companies, the supply side, have a duty to underwrite insurance at the premiums specified by law (CA L125-2), but this duty is waived when insurance applicants do not comply with the land use controls specified by the relevant PPR (CA L125-6). The insurance companies charge legally set uniform premiums without undertaking risk assessments.

Among France's citizens, 95–98 % have joined the CatNat insurance system (OECD 2006, p. 23). Table 21.9 shows the trends of the original CatNat premium, whereas Fig. 21.9 shows the trends of the CatNat insurance payments by disaster type. The amount of the insurance payments varied by year, and they exceeded the premium incomes in some years. Based on the data from 1990 to 2011, floods were the primary disaster type, accounting for 58 % of all insurance payouts, followed by ground subsidence (38 %), and others (4 %).

21.3.3.2 Role-Sharing Between the Government and the Private Sector in Insurance

The state government plays a leading role in the CatNat system's design and operation. The system's mechanisms are specified by law, including the method to set premium rates, the mechanism of public reinsurance, and the mechanism to certify the subject disasters. First, the law stipulates that standard property insurance must include insurance for natural disasters (CA L125-1, L125-2). The insurance companies collect 12 % additional premiums, specified by law, as premiums for disaster insurance (CA L125-2). This premium rate is uniform throughout the country and is not set based on risk. The insurance companies can reinsure the underwritten insurance with CCR (Caisse Centrale de Réassurance), which is a 100 % state-owned company. There is no limit on this reinsurance and it is warranted by the government.

It is mandatory that private insurance companies sell CatNat with their own property insurance products. Because the insurance companies do not have to conduct risk assessments, and the semipublic reinsurance system is well developed, CatNat's role in encouraging disaster mitigation is limited.



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Flood	505	95	646	993	467	772	314	211	190	955	491
Subsidence	871	474	364	439	103	191	626	477	569	62	49
Others	0	0	0	0	0	185	96	0	0	80	0

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Flood	493	1,022	1,423	23	204	166	185	409	201	1,239	292
Subsidence	12	283	1,189	40	418	138	161	42	228	41	750
Others	0	131	0	75	0	0	282	0	0	0	0

Source: CCR, "L'indemnisation des Catastrophes Naturelles en France, 15 Janvier 2013"

Fig. 21.9 Trends of the CatNat insurance payments by disaster type

21.3.3.3 Linkage Between Natural Disaster Insurance and Land Use Control

One of the distinctive features of French land use control for disaster mitigation is that insurance and land use control are linked as a legal system. As discussed above, the implementation of a PPR is indirectly ensured by excluding those who do not follow its provisions from the insurance system. In this light, the French CatNat system seems to play a role in disaster mitigation. However, some questions have been raised about the effectiveness of the exclusion provision. A 2005 report, issued by the inspector general to the relevant ministers, regarding the application of the provision waiving an insurance company's duty to underwrite insurance (CA L125-6), stated that "the insurance companies seem very unlikely to take the trouble to detect violation cases of the provision of PPR by insured persons." Furthermore, the report asserted that because the insurance companies have discretion whether or not to underwrite the insurance, "this provision has been actually applied to extremely few cases." The report, therefore, proposed making the exclusion of violators from the insurance system mandatory and not leaving it to the discretion of the insurance companies (Inspection Général des Finances et al. 2005, pp. 24–25). However, this proposal has not been realized as of today, probably because of the virtually impossible task for the insurance companies to confirm the compliance by individual insured persons with the PPRs.

France has established another system that facilitates the development of PPRs using an insurance system. Typically, the insurance has the so-called deductible clauses that stipulate that a certain amount of damage will not be paid by the insurer. CatNat also has deductible clauses (Table 21.10).

For insurance contracts that are entered into by citizens who live in a commune which have not developed PPRs, until a PPR is developed in their residential area,

Table 21.10 Deductible applied to the natural disaster insurance (CatNat)

Targeted contract and property	Natural disaster except subsidence	Subsidence
Residential houses, movable property, automobiles, and other properties except for commercial use	380 Euro	1520 Euro
Automobile for commercial use	380 Euro (when the immunity from responsibility of the main contract is higher than this, corresponding deductible is applied)	–
Commercial buildings, movable property	10 % of direct damage of property and 1140 Euro minimum	3050 Euro
Economic loss	Minimum of 1140 Euro (when the immunity from responsibility of the main contract is higher than this, corresponding deductible is applied)	3050 Euro

Source: CCR (2011), p. 6

the deductible will be increased based on the number of natural catastrophes that have occurred and have been certified by the government. In this system, for the first and second disaster, the deductible is determined according to Table 21.10. For the third, fourth, and fifth (or more) disasters, the deductible is increased to double, triple, and quadruple amounts, respectively. The state government's goal is to encourage the development of PPRs that serve as a basis for regulations by gradually lifting the hurdles for insurance payments for areas that experience natural disasters frequently.

21.3.3.4 Utilization of the Barnier Fund

Finally, we will discuss a mechanism that combines insurance and land use control from the perspective of premium revenues. In France, although there is no compensation for land use control itself, there is a compensation scheme for the expropriation or purchase of properties in an area subject to regulations by PPRs and other regulations. (CE L561-1, L561-3). If there are major threats affecting human lives and there are no defensive measures available at a lower cost, the expropriation and purchase of the property is allowed. Additionally, after such purchases, the properties are subjected to use restriction or demolition (MISILL, MEFI et MEDD 2005, pp. 18–19). In such a context, the Barnier Fund,[36] a fund for the prevention of major natural disaster risks, was established in 1995 (MEDAD 2006). Although this fund was designed to be used for the payment of these purchases, very few buildings have actually been purchased using the fund (Fiselier and Oosterberg 2004, p. 49; OECD 2006, p. 26).

The fund's financial support is derived from a 12 % charge on the aforementioned additional 12 % premium (namely, 1.4 % of the total premium), which is

[36] Le fonds de prévention des risques naturels majeurs (FPRNM), "Fonds Barnier"

Table 21.11 Expenses from Barnier Fund (FPRNM) from 2008 to 2012 (Million Euro)

Year	2008	2009	2010	2011	2012
Expense	64	79	254	226	113

Source: CCR, "Presentation des Fonds Public, 15 janvier 2013"

collected as the premium for natural disaster insurance (CE L561-3 II). In addition, contributions from other national treasury sources are also possible (CE L561-3 II). Initially, the fund was established to finance the expropriation of properties, but the application of the fund has been gradually broadened by legal revisions. Now, the fund is used to fund PPR development, to subsidize the expenses for measures required by PPRs, and to finance the expenses for survey and construction work for disaster prevention that are conducted by local authorities (MEDAD 2006). The fund expenses for 2008–2012 are shown in Table 21.11.

As shown above, the fund contributes to disaster reduction by using a portion of the insurance premiums for the development of PPRs, which are primarily collected to be used for insurance payments to disaster victims. In this way, the fund serves as another link between the PPRs and natural disaster insurance.

21.3.3.5 Appreciation and Criticism of CatNat System

As described above, since the CatNat system is backed by the state government and the premium rates are uniformly set by legislation, the insurance companies do not collect insurance premiums according to the risk incurred, as would be determined by conducting a risk assessment. Therefore, the country's insurance system does not take advantage of the economic function of insurance, which promotes the withdrawal of residents from the high-risk areas or induces them to take disaster mitigation measures through market mechanisms. Instead, the country's insurance system puts a focus on insurance's function as a social system. The basic philosophy of the CatNat system is to secure the solidarity of the nation's society (Inspection Général des Finances et al. 2005, p. 4).[37]

Therefore, the French system has been evaluated as effective due to its high insurance ownership rates and good coverage (OECD 2006, p. 23), whereas the combination of land use control and insurance system has received some criticism. It says that "although its effectiveness has been demonstrated for new development, there remains a major problem in disaster preparedness measures on existing buildings" (Fiselier and Oosterberg 2004, p. 54) and also that "it does not work effectively enough as an incentive because owners' preventive measures are far remotely related with the underwriting of insurance … [PPRs] do not constitute a systematic guarantee of the control of urbanization in flood-prone areas. The problem seems particularly serious in regions where demographic and economic pressures lead to

[37] In the interview at CCR, it was explained that no one in France regard it as strange or unfair that people living on the first floor and those on the third floor pay the same premium" (Interview (5)).

the continuous expansion of business and residential areas" (OECD 2006, p. 24, p. 34). The essence of such criticism is that because any future damage will be fully covered, the insurance system prevents the citizens' from making efforts on disaster mitigation, resulting in a moral hazard.

21.3.3.6 Movement for Reform of the CatNat System

To address these challenges, work to reform the natural disaster insurance system was initiated. In February 2005, the inspector general (inspection général) was asked to evaluate the current system and deliver proposals to reform the system to relevant ministers such as the Minister of the Interior. In September 2005, a summary report was published (Inspection Général des Finances et al. 2005) that proposed introducing a system that sets premiums based on risk assessments. However, this proposal was a conservative one because it proposed introducing premium bands based on a range of risks while still maintaining the basic principle of the "mutual aid." After receiving this report, the government drafted a reform bill for viewing by stakeholders including the insurance industry and invited their comments. Accordingly, the French Federation of Insurance Companies (FFSA, Fédération Française des Sociétés d'Assurance) issued a communiqué dated November 22, 2006, which concluded, after noting that the differentiation of the insurance premiums would result in weakened solidarity among French citizens, that the introduction of differentiated premiums was not necessarily an effective measure to encourage disaster prevention measures and that other measures should be examined (FFSA 2006). However, based on the government's initial draft, the Federation delivered a new proposal that the insurance premium rates for companies' business use would be set based on risks, from 6 to 18 %, whereas the premium rates for households would be uniformly maintained (Interview (5)).

As seen above, although the partial introduction of risk assessment into the insurance system is now under consideration, the discussion has not advanced smoothly, partly due to the insurance industry's negative opinion. Although there is a possibility that emotional factors that are specific to French citizens, including "solidarity" and "mutual aid," prevent the advancement of this issue, we can also infer that under the current French system in which the state government takes all the risks, insurance companies do not have any motivation to change the current status quo.[38]

[38] However, the reform movement reemerged in 2010 when Cyclone Xynthia hit France and caused 53 deaths (FFSA 2011, p. 3). In April 2012, an amendment bill about the natural disaster insurance system was sent to the state parliament (N°491, SÉNAT Projet de Loi partan réforme du régime d'indemnisation des catastrophes naturelles, le 3 avril 2012). The aim of the amendment was (1) to improve the imprecision of the system that caused unfairness and the lack of transparency and (2) to enhance the incentives for disaster prevention. For the first goal, the amendment bill included a provision to divest the right to receive insurance from those who violated the PPR provisions once a PPR was formulated. To achieve the second goal, the bill included a provision to apply premium rates to private companies and local governmental bodies above a certain size that are set according to both the risks and the disaster preparedness measures taken. This provision stipulated that the

As discussed above, the problem of moral hazard in France still remains unresolved despite repeated attempts at systemic reforms. Originally, a series of systems centering on the PPR began with relief for natural disaster victims and then the disaster prevention functions of the systems have been gradually reinforced. However, the discussion on reforming the systems has continued, while the two perspectives, disaster victim relief and disaster prevention, have not yet been effectively combined.[39] Although the country's natural disaster insurance system has not yet experienced a stalemate, there is concern about its sustainability due to the increased risks such as the global environmental problems.[40] Since the French insurance system is designed so that the natural disaster insurance and land use control support each other, when the former's sustainability is increased, it leads to a more stable basis for the latter. Because of the increased risks, this discussion is expected to be continued in the future. Generally speaking, there is a certain amount of "trade-off" between the two perspectives, (1) giving sufficient relief to disaster victims and (2) promoting incentives for disaster mitigation measures. We expect that the country will continue to discuss this issue while pursuing the best balance available.

21.3.4 Summary: Features of the French System

21.3.4.1 Qualitative Risk Assessment

The risk assessment in France is qualitative for the land use control for natural disaster mitigation. This is based on the country's experience that the previous land use control system which required strict and rigid risk assessment resulted in delays in assessment work and increased costs. Even today, assessments are implemented based on "common sense" (bon sense) under a "precautionary principle" while allowing a certain level of uncertainty. In the French natural disaster insurance system, risk assessment is not undertaken because the premium rates are not set based on risks. However, in the recent reforms, the possibility of introducing risk-based insurance premiums has emerged.

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range of premium rates (highest and lowest rates) should be designated by ordinance. This bill has not been enacted as of now.

[39] "Although natural disaster reduction policies and disaster victims relief policies are parallel, those policies seems to be unconcerned each other. Thus, some kind of reform is required to converge those" (Inspection Général des Finances et al. 2005, Resume et conclusions p. 3).

[40] In the chief budget inspector's report, it is pointed out that while the payment of insurance claim increased 5.3 % annually, the insurance premium increased only 4.1 % annually from the year 1989 to 2003, which raises a question about the sustainability of the system (Inspection Général des Finances et al. 2005, p. 7).

21.3.4.2 Land Use Control for Disaster Mitigation Through a Specialized Planning System and Realistic Land Zoning

In France, in addition to the normal city planning system, another planning system specialized for disaster mitigation has been developed. It belongs to the national administration separate from that of normal city planning. This system not only has stronger regulatory powers than the city planning but also could be applied immediately on the governor's initiative without usual public inquiry procedure. On the other hand, the country has implemented realistic land use zoning considering the local areas' actual conditions using qualitative risk assessment measures, which balances the strong necessity for disaster mitigation with indispensable consideration for the reality of the local areas.

21.3.4.3 Natural Disaster Insurance with the Focus on the Social Function

As the French natural disaster insurance system is financially supported by the state government and the premiums are set by legislation, the insurance companies do not assess risks, and their insurance premiums are not risk based. Therefore, the French system does not take advantage of insurance's economic function. Instead, France's insurance system puts an emphasis on insurance's function as a social system. The basic philosophy of the French system is to ensure the solidarity (solidarité) of the nation's society. Due to these features, the country's system has been evaluated as effective in terms of its high ownership rates and good coverage, while the citizens' efforts on disaster mitigation are not encouraged, eventually resulting in moral hazard among residents. In this context, there have been made continuous efforts to reform the system.

21.3.4.4 The Comprehensive Policy Instruments in Which All Systems Are Closely Organized in a Legal System

The French system indirectly secures the effects of the land use control by excluding those who violate the provisions of a PPR from the natural disaster insurance, whereas a part of the premiums are used for risk reduction measures (e.g., PPR development, expropriation of dangerous land, etc.) through the Barnier Fund. In addition, in communes with PPRs, the communes must respect the PPRs in their city planning, and the concerned mayors must raise the residents' awareness of disaster mitigation through public meetings with residents at least once every 2 years. Real estate owners in the PPR areas have a duty to provide disaster-related information on their properties to the opposing parties when selling or leasing them. In this way, a number of policy instruments have been deliberately assembled in a legal system surrounding the PPR.

21.3.4.5 The State Government's Leading Role

In land use control, the disaster mitigation plans are formulated by the state government, in spite of the fact that they are applied locally at the municipality (commune) level. The state government plays a major role not only in the system's design but also in its operation through giving initiative to the governors, who serve as branches of the state government when establishing the PPR, especially in the case of immediate application. Furthermore, in the natural disaster insurance system, the state government also plays a leading role not only in establishing the system by setting the nationwide uniform premiums but also supporting it financially by reinsurance scheme.

21.3.4.6 The Stream from the Post-disaster Relief to the Pre-disaster Mitigation Policy

Originally, the PER, which was the precedent system of the PPR, was proposed to serve as a system to give post-disaster relief to disaster victims. Then, a land use control function was added to the system during the law-making process. Now the system is evolving toward the reinforced policy of pre-disaster mitigation, by enhancing the application of the Barnier Fund, introducing a deductible scheme into the insurance well as discussing the possibility of differentiating insurance premiums based on risks. Although we have not yet seen major developments, efforts are continuously made to improve the disconnect between natural disaster insurance (a system to give relief to disaster victims) and PPRs (a system for disaster prevention).

21.4 Conclusion

When we compare the land use management systems for natural disaster mitigation in the UK and France, we first notice that both countries have entirely opposite positions on very essential issues, such as how they use market principles in their whole land use management systems and how they assess disaster risks. These major differences seem natural, though, in light of the fact that both countries have different natural and social conditions as well as their own unique histories.

In order to understand both countries' land use management for natural disaster mitigation and to apply lessons from them to other countries, it is important to know how these systems are working and how much effectiveness has been demonstrated for natural disaster mitigation. However, needless to say, it is very difficult to clarify them. This is because the apparent effectiveness of these management measures may also result from changes in the natural conditions (e.g., global warming and accidental weather conditions) and social conditions (e.g., population and industry), as well as from the impacts of other policy measurements. It is quite difficult to separate the contributions of these factors.

Nevertheless, when we try to learn from the land use management systems of the UK and France, we can learn, at minimum, the following two lessons. The first is to employ every possible policy instrument. It should be an effective basic strategy for every society to combine land use management not only with regulations but also with other policy instruments such as disclosure of information and disaster insurance. The second lesson is to maintain a flexible attitude, where the efforts to incorporate an opposite perspective are continuously exercised, while the fundamental position is maintained. Neither the UK nor France has achieved perfect forms of land use management, but both are still evolving. To address the difficult challenges of land use management in continuously changing societies, it is critical to flexibly pursue the best management system by trial and error. This will eventually lead to the most effective ways to realize the optimum systems:

Interview

1. Flood Management Division, Department for Environment, Food and Rural Affairs (November 24, 2008)
2. Association of British Insurers (ABI) (November 25, 2008)
3. Flooding, Coastal Erosion, and Water Planning Branch, Ministry of Community and Local Governments (November 25, 2008)
4. Sous-Directeur de l'Urbanisme et de la Construction, Préfecture de Paris (November 27, 2008)
5. CCR (Caisse Centrale de Réassurance) (November 28, 2008)
6. Direction de la Prévention des Risques, MEDAD (Ministère de l'Ecologie, du Dévelopment et de l'Aménagement Durables) (November 28, 2008)

Appendix

Fundamental Concepts of Insurance and Flood Insurance Systems in the UK and France

1. *Insurance as an economic system based on individualism*
   Where can we discover the very nature and significance of insurance? First, we can find them in its function to facilitate and streamline economic activities by converting the societies' uncertain risks into fixed costs. For example, business owners always face various risks, including those of natural disasters, but securing reconstruction funds for the potential risks can be an operational burden for their companies. Additionally, if all the business owners prepare for risks that are only stochastically realized, it will become a huge social loss. To address such a situation, if each business owner can secure the company's reconstruction costs by paying an insurance premium as a fixed cost, it can be beneficial not only for

the company but also for the whole economy (we can also say this about the residential insurance system). From the perspective emphasizing this insurance function, it is important that each insurance contract satisfies the principle of equivalence, namely, when P is the insurance premium, ω is the risk, and Z is the insurance payout, it is necessary that the relationship below be satisfied:

$$P = \omega Z$$

From this position, it is important to calculate each person's risk as accurately as possible. In other words, a "subdivision of risk assessment" (underwriting of risk) is needed. Therefore, persons who face high risks must pay high premiums. This perspective considers the property insurance system as an economic system composed of each individual contract. Thus, we can call insurance as seen from this perspective as "an economic system based on individualism." The reasons that this position requires the subdivision of risk assessment can be summarized in the following two points:

(i) An insurance system that does not distinguish between groups of individuals with different risks results in a decrease of efficiency in the insurance market and a lowered level of welfare of the whole society (an occurrence of deadweight loss).

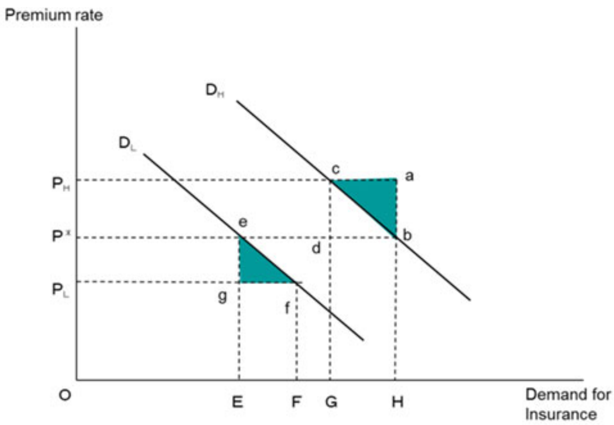
Figure 21.10 shows the demand curves for the insurance of two groups: one group faces higher risks and the other group faces lower risk (the former is D_H and the latter is D_L). Now we assume that the premium for the high-risk group is set high (P_H) and that for low-risk group is set low (P_L), based on the risk that each group faces. Here, if the premium is set identical (P^*) for the both groups without taking into account the risk that each group faces, the welfare equal to the area of the two triangular shapes (◿abc and ◿efg) is lost, providing a loss for the whole economy.

(ii) Insurance that does not accurately distinguish groups with different risks loses economic fairness.

Principles of fairness would indicate that "people who face the same risk pay the same premium rates, whereas people who face different risks pay different premium rates." However, if premium rates are not set according to the risks that people face, unfairness occurs between insured groups as shown in Table 21.12. This will result in the withdrawal of the low-risk group from the insurance system and an influx of the high-risk group into it (i.e., adverse selection). In an extreme case, the insurance system itself becomes unable to exist anymore.

2. *Insurance as a social system based on collectivism*

Another position considers insurance as a social system based on collectivism. This position views the role of insurance as a method to help people who suffer from accidental events, such as natural disasters, with the spirit of mutual aid within society. This position is based on the concept that society as a group protects itself against unknown risks, as opposed to the concept that insurance is a



When premium rates which correspond to the risks of different groups (P_H, P_L) are changed into a unified average premium rate (P^*), the welfare equal to the area of the two triangles (△abc, △efg) is lost.

Fig. 21.10 Risk assessment and welfare loss

Table 21.12 Relationship between insurance premium classification and actual degree of risk

		Low-risk group	High-risk group
Actual risk	Low	(1)	(2)
	High	(3)	(4)

1) In the cases of (1) vs. (2) and (3) vs. (4), there is unfairness in that the groups facing the same level of risk are charged by different premium rates (horizontal unfairness)
2) In the cases of (1) vs. (3) and (2) vs. (4), there is unfairness in that the groups facing different levels of risks are charged by the same premium rate (vertical unfairness)

kind of economic system in which only individuals who pay money can receive benefits according to those payments. Therefore, under this concept, the system should not be one in which only part of the society can participate nor be one from which underprivileged people are excluded. The insurance system should be one in which every member of the society can enjoy the benefits equally. Originally, insurance systems were born as social systems. Then, as techniques of risk assessment developed, the insurance function as an economic system developed accordingly. Viewing insurance as a social system based on collectivism is a position that justifies the income redistribution in the insurance framework in order to give relief to vulnerable people. For this position, underwriting of risk is not needed.

3. *The balance between an economic system and a social one*
If the underwriting of risk is developed with an emphasis on the insurance system's economic side, efficient and fair insurance systems can be established. However, when such an emphasis is pursued to an extreme level, there will be concerns that some people will be unable to obtain insurance. When applying this concept to a flood insurance system, the premiums for poor people who tend

to live in areas with high flood risks become prohibitively high, and the disadvantaged people are excluded from the insurance system. This is a socially unacceptable situation.

On the contrary, when emphasis is put on the insurance system's social side and no attention is paid to the economic characteristics, economic welfare will be lost due to the lopsided insurance market, and horizontally and vertically unfair situations will be brought about. In addition, there is another concern that the insurance system might be unable to exist anymore due to adverse selection, in which only those who face higher risks demand insurance. Furthermore, in such a situation, there are some concerns about moral hazard developing among people who live in the dangerous areas, and it may prevent people's action toward disaster prevention and damage mitigation.

We can consider an insurance system as an economic one or social one. It is a matter of perspective, and the ultimate goal is achieving the best balance possible between the two perspectives. An insurance system which puts extreme emphasis on either perspective will cause serious problems. What is important is what kind of problems we can resolve with insurance and how they can be resolved. That will depend on the specific situation of each community.

4. *The UK and France's perspectives on insurance in the context of land use control for disaster prevention*

   The UK and France use their own unique insurance systems in their land use management for natural disaster prevention. In the UK, the insurance system is viewed as an economic system and is designed using market principles. On the other hand, in France, the insurance system is viewed as a social system and is designed using the principle of solidarity (solidarité).

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Chapter 22
River Basin and Land Use Lessons from Japan: Influences of Changes of Industrial Structure on Land Use of Nagara Basin and Flood Risk Control

Michiko Banba

Abstract Land developments and construction of factories or logistic centers should be implemented with the well-considered land use plans by taking account of disaster risks to improve the resilience of the region to mitigate damages. In this paper, the relationship between regional development and land use is discussed from the perspective of flood risk control. Nagara basin in Gifu Prefecture (Gifu, Mino, and Seki cities), where transportation network has been developed to raise the potential for more development, is selected as a case study site. First, changes of industrial structures of the region and its influences on land use were analyzed. Then, possible flood control measures were summarized, and issues from the land use perspective are analyzed.

Keywords Land use policy • River basin • Regional development

22.1 Introduction

Sustainable development was defined in Brundtland Report as "development which meets the needs of current generations without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987). It is our responsibility to leave a beautiful natural environment to the future generation; however, it sometimes conflicts with our economic environments. Moreover, intervention to the natural force can cause or enhance disaster. Appropriate land use practice is a key to cooperate with nature and land use planning measure to balance those (Burby 1998).

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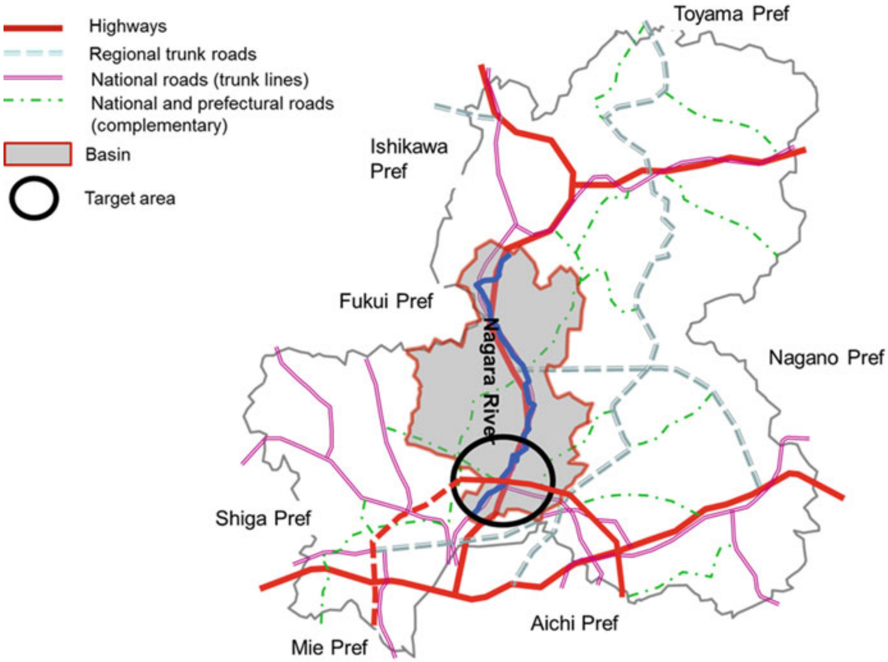


Fig. 22.1 Nagara River basin and transportation network

As a local region is developed, infrastructure (e.g., roads, commercial facilities, factories) and residential districts are actively constructed, and the regional industrial structure and land use are subsequently altered in an interactive manner. Although it is desirable to implement development processes following a master plan for city planning or land use, this is not always the case, which causes concerns that deregulated development and land use may not align with the applicable city plans. It is also possible that a master plan exists, but the city and land use plans were developed without sufficient consideration of disaster risks, resulting in unrestricted use of high disaster risk areas. Thus, land use must also be controlled from the viewpoint of disaster risk mitigation.

In the basin of the Nagaraj River in the Gifu Prefecture (Fig. 22.1), especially in the middle basin (Gifu, Seki, and Mino cities), the land use has changed as industrial core areas, and the associated residential areas have been developed. The flood control measures in the middle basin may significantly affect the potential flood damage in the downstream basin. Because it is difficult to fundamentally mitigate flood damage using only flood prevention facilities in a downstream basin, comprehensive flood control measures must be considered from the perspective of land use. However, flood risks have increased as local regions are actively developed.

It is discussed how land use, which is the result of development intended for revitalization of the region's economy, affects flood risks. Flood control and flood damage mitigation measures in the basin of the Nagara River are discussed, and problems are analyzed based on the relationship between flood risk control and land use. Finally, future tasks for flood risk control measures through land use control are presented.

22.2 Changes in the Industrial Structure in the Middle Basin of the Nagara River

22.2.1 Increase of Factories Due to the Development of Transportation Networks

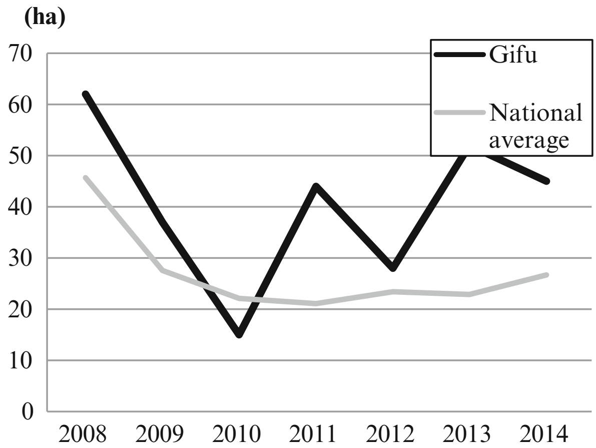
Factories built around the middle basin of the Nagara River as well as those built in the Chuno region (the middle Mino region) have altered the population in the area. Due to the prefectural land 1700 km Framework Arterial Network Initiative, which aims to reinforce the relationships between Gifu and the Hokuriku region (northwestern part of Honshu Island), the Tokai region (western part of central Japan), the Kinki region (southern part of central Japan), and the Tokyo Metropolitan Area, the transportation infrastructure has been vastly expanded; in addition to the local high-standard highways that connect major cities and the supplemental road network that connects to other areas in the prefecture, arterial high-standard highways connect major cities in the region and throughout Japan (Fig. 22.1). The initiative also strives to improve access to major transportation hubs such as the Chūbu Centrair International Airport, the Port of Nagoya, and the Port of Toyama and promote overseas exportation.

Thus, this region has become a production and logistics hub as these wide-area transportation nodes and networks have been developed. Since 2005, the number of factories constructed in the Gifu Prefecture has increased. Although there was a lull in the latter half of 2009, the construction has increased since then due to the new construction and relocation of manufacturing facilities into the area after the Great East Japan Earthquake (Fig. 22.2). Gifu has overtaken the Aichi Prefecture in the total area of land used for factory construction and is now the second largest in Japan. Moreover, Gifu is now the third largest in terms of factories constructed. The future development of the transportation network is expected to sustain this upward trend.

22.2.2 Changes in the Population Structure

Due to the recent increased factory construction and the resulting changes in the industry structure, the ratio of the working population in Gifu Prefecture industries has been significantly altered. In Gifu City, the ratio of the population working for primary and secondary industries has decreased, while that of tertiary industries has

Fig. 22.2 Area of manufacturing factories in Gifu Prefecture (Source: Gifu Prefecture, 2016)



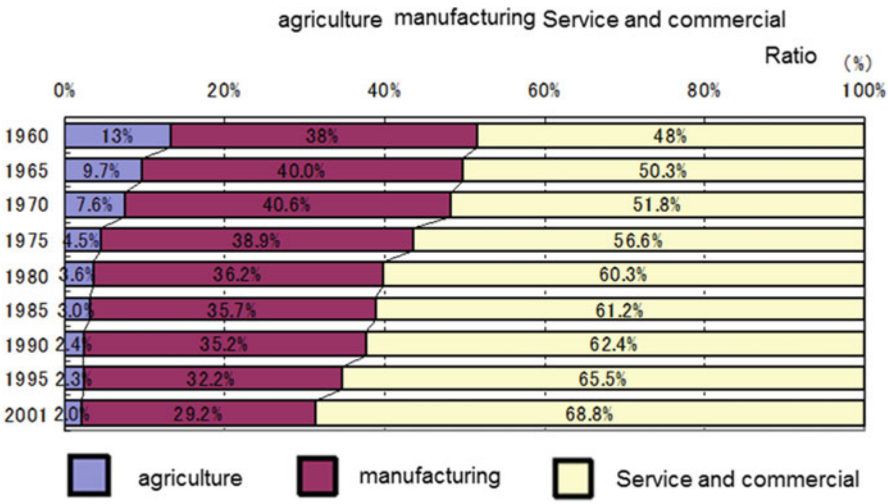


Fig. 22.3 Ratio of employees of agricultural, manufacturing, and service and commerce industries of Gifu City (Source: Gifu City 2007)

increased and accounted for 70 % in 2001 (Fig. 22.3). In Mino City, although 40 % of the working population engaged in primary industries in the 1960s, which was the largest sector back then, over the last four decades, the percentage has decreased to just over 3 %. On the other hand, those working in secondary and tertiary industries have increased to about 50 % in 2001 (Fig. 22.4). The decreased working population in agriculture has caused a lack of successors and an increase in abandoned farmlands, which have resulted in changes in the city's land use, including conversion of agricultural land for land to construct factories due to the increased demand.

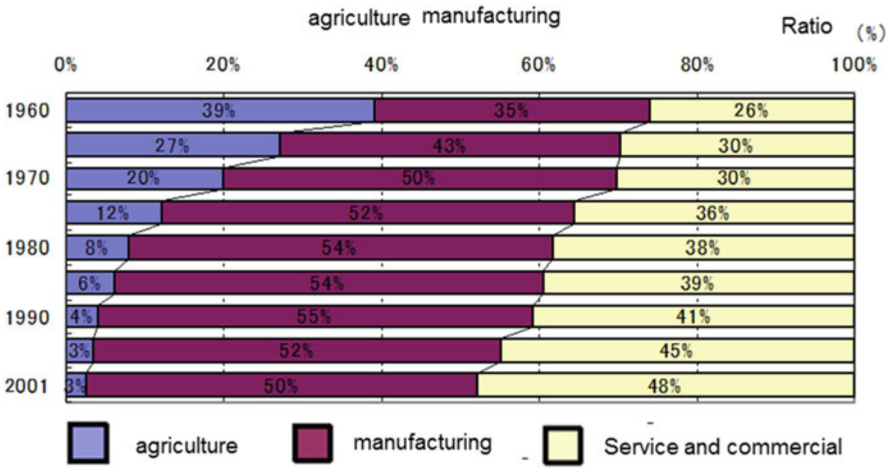


Fig. 22.4 Ratio of employees of agricultural, manufacturing, and service and commerce industries of Mino and Seki cities (Source: Mino City 2002)

22.3 Impact on the Land Use in the Middle Basin of the Nagara River

22.3.1 Analysis from the Planning Perspective

Here, we explore concepts and plans on regional development, which are described in the master plans for Gifu, Seki, and Mino cities. Seki and Mino cities have a city planning policies that strive for harmony between people and nature, while Gifu City aims to develop a safe and secure city. Under such concepts, the development of industrial cores has been planned along the Nagara River (Fig. 22.5). Development of transportation network has facilitated those industrial activities.

22.3.2 Land Use Pattern

The Gifu Prefecture has a number of municipalities with areas that are not classified into urbanization promotion areas or urbanization control areas under the City Planning Act of Japan (hereinafter referred to as “nonclassified areas”). Around the middle basin of the Nagara River, there are a number of urbanization control areas and nonclassified areas. Areas belonging to Gifu City are classified as use districts or urbanization control areas, whereas those belonging to Seki City and Mino City are classified as use districts or nonclassified areas. In urbanization control areas along the river that belongs to Gifu City, the development is somewhat suppressed, but construction under Article 34 of the City Planning Act of Japan allows for

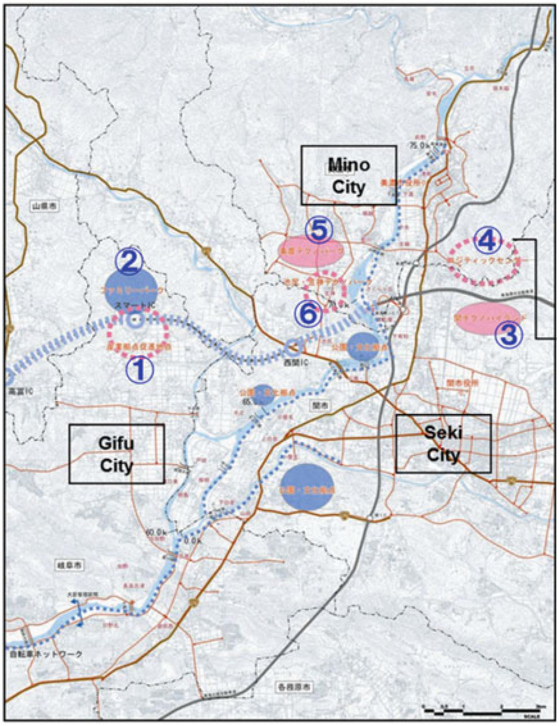


Fig. 22.5 Location of industrial complex (Source: Revised materials provided by officials of Gifu Prefecture). *1* Smart interchange construction plan *2* Recreational facilities *3* Seki Techno Highland (industrial park) *4* Mino Techno Park (industrial park) *5* Ikejiri-Kasagami Techno Park (industrial park) *6* Logistic Center (Source: Gifu Prefecture 2006)

development activities in urbanization control areas subject to certain conditions. In nonclassified areas in Mino City and Seki City, many small-scale projects may be developed, considering the development permission standards.

In addition, areas along the Nagara River have many regions that are designated as agricultural promotion areas or agricultural zones under the Act on Establishment of Agricultural Promotion Regions, which makes development difficult because regulations require permission to convert agricultural land to nonagricultural land. However, such conversions may be considered because the lack of successors has resulted in an increase in abandoned farmland. As the demand for land to construct factories rises and the pressure to convert agricultural land increases, the conversion of farmland into factory sites may become more active. It should also be noted that factory construction has economic benefits on the regional development (e.g., generates job, increases demand for housing development, etc.).

Such factory construction and land use do not have clear positions in applicable master plans. Consequently, this development may not align with the master plans

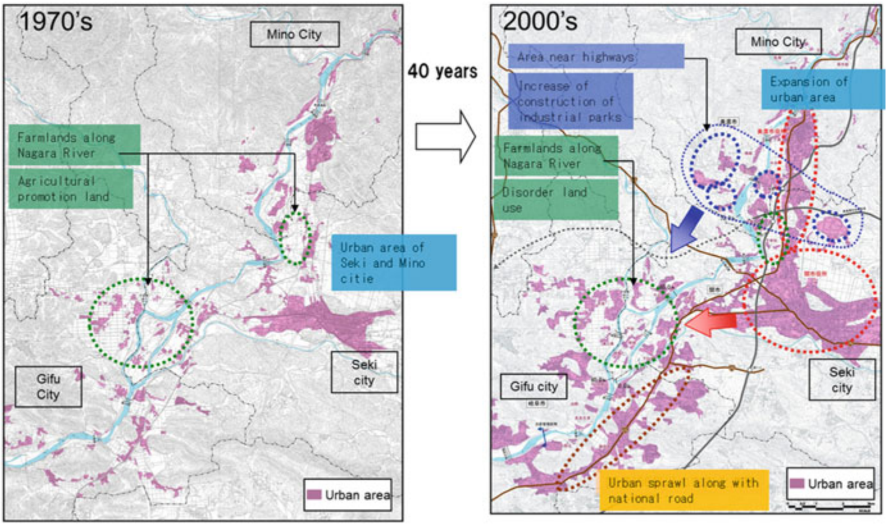


Fig. 22.6 Land use of the 1970s and 2000s (Source: Revised materials provided by officials of Gifu Prefecture)

developed from a long-term and comprehensive viewpoint. In addition, use districts under the City Planning Act are often designated after development activities have been initiated. Such a situation shows that regulations and guidance based on the applicable land use plans and master plans are not effectively implemented.

Comparing land use in 1970 with that in 2010 (Fig. 22.6), it is obvious that the urban district has expanded in the past 20 years. In particular, expansion of the urban district in the basin of the Nagara River has resulted in a moth-eaten appearance. The land surrounded by the dotted line is the land that has been improved to be a superior agricultural land under land improvement projects, etc. However, some of this land has been converted into residential housing land.

Additionally, some districts in areas with expanded urban districts are categorized as 1 or 2 low rise-rise exclusive residential districts or 1 or 2 medium-to-high-rise exclusive residential districts although they belong to urbanization control areas. Although designation of use districts has been mostly positive, such designations following the previously initiated development activities are not well planned.

22.3.3 Relationship with Agricultural Land

Although the conversion of agricultural land should adhere to the standards for conversion of agricultural land, the conversion standards do not include disaster prevention. Agricultural lands provide flood control functions, but are currently not conserved in a well-planned manner.

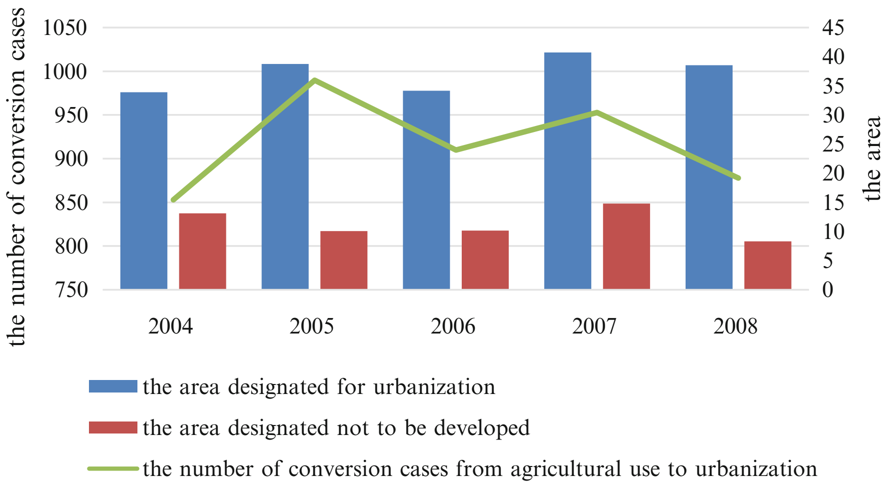


Fig. 22.7 Conversion to agricultural land (Source: Seki City 2007)

In agricultural land located in low altitude areas across Seki City and Gifu City, agricultural land continues to decrease and small-scale development projects are common as the development potential has increased and urban districts are actively expanding. There is a concern that the subsequent infrastructure upgrades of highways and the expansion of industry may further advance urban sprawl. Figure 22.7 demonstrates this relationship.

22.4 Changes in Land Use and Flood Risk

22.4.1 Relationship with Agricultural Land

Although the conversion of agricultural land should adhere to the standards for conversion of agricultural land, the conversion standards do not consider factors for disaster prevention. Agricultural lands provide flood control functions, but are currently not conserved in a well-planned manner. Agricultural land located in low altitude areas across Seki City and Gifu City continues to decrease, and urban districts are actively expanding because of the pressure for more developments. There is a concern the subsequent infrastructure upgrades of highways and the expansion of industry may further advance of urban sprawl. Figure 22.8 demonstrates this relationship.

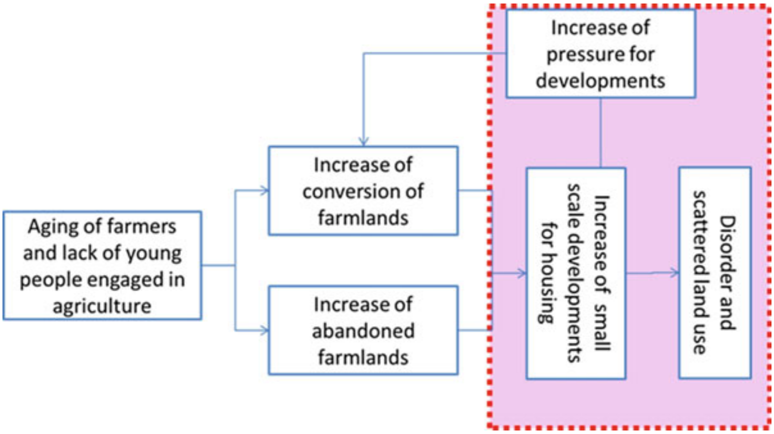


Fig. 22.8 Relationship of factors from the agricultural point of view

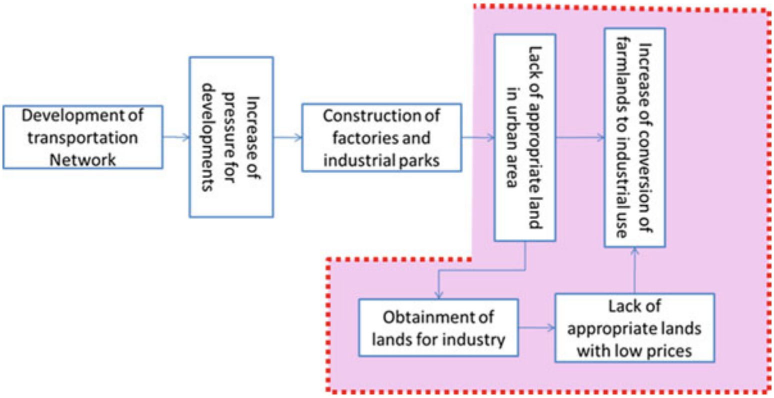


Fig. 22.9 Relationship of factors from the industrial point of view

22.4.2 Relationship with Industry (Regional Development)

The development of an expansive road network attracts businesses into an area. Due to a shortage of land suitable for factory construction and economic factors, deregulated development not based on land use plans or flood risk may be initiated.In the hills along the Nagara River across Mino City and Seki City, large-scale development projects, including industrial parks, have been undertaken following highway construction. Sometimes, easy development projects are even initiated. Figure 22.9 shows these relationships.

22.5 Consideration of Flood Control and Flood Disaster Mitigation Measures

22.5.1 Current Situation

One of the problems of flood control measures in the basin of the Nagara River is the lack of a cross-section area of the river channel, leading to issues with safely discharging severe flood flows. For example, the most severe flood since the end of World War II occurred in October 2004. In addition, as regional development associated with the construction of the Tokai-Kanjo Expressway proceeds, more agricultural land will be developed, reducing the flood control function and raising concerns of increased flood damage. Urgent and deliberate measures that will continuously ensure inherent flood control effects are needed.

Moreover, the concern of flood damage in the middle basin and the disaster potential in the lower basin have increased because converting agricultural land into residential housing land involves leveling off the ground, which decreases the lands' flood control function. Accordingly, the disaster potential in the lower basin has increased, requiring further leveling of buildings. Although local governments have promoted leveling with subsidies or others, flood risk mitigation is not assured. Figure 22.10 shows these relationships.

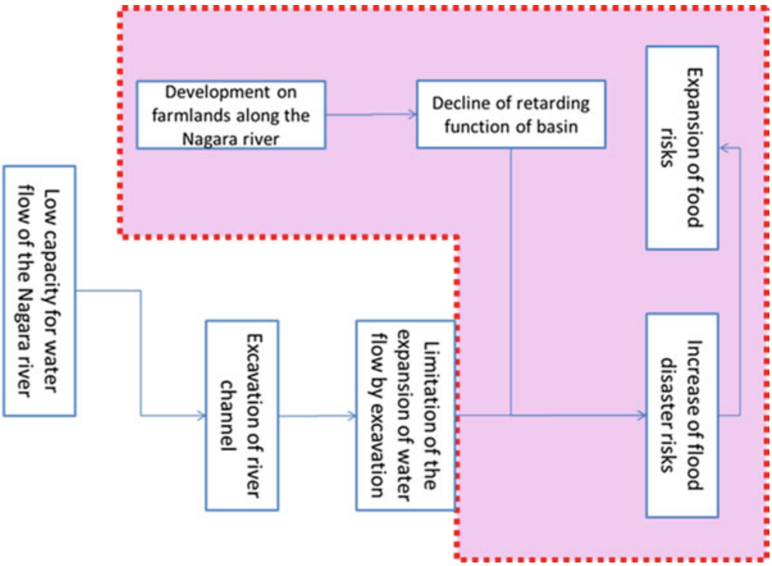


Fig. 22.10 Relationship of factors from the flood risks and control measures

22.5.2 Techniques for Flood Control and Flood Disaster Mitigation

Major flood control techniques include (1) river channel improvement and (2) flood control facilities. We consider the methodology and efficacy of these techniques in the basin of the Nagara River.

22.5.2.1 River Channel Improvement

Flood control measures from the perspective of the river channel include setting back a levee, raising the banks, and river channel dredging. Based on its analysis, the Chubu Regional Development Bureau (CRDB) of Ministry of Land, Infrastructure, Transport and Tourism, Japan (MLIT) has concluded that setting back a levee or raising the banks is unrealistic. These techniques may include river channel dredging and river widening, but both have complicated environmental considerations and require a huge amount of financial and human resources, limiting their applications:

- Setting back levee significantly affects the urban districts along the river and their land use because these areas have accumulated population and assets.
- Raising the banks raises the high water level (HWL), which may increase damage due to landside water and flood damage if a dyke breaks.
- Dredging and widening the river channel (riverbed) will enhance the discharging capacity, but a high water bed width is required to ensure that a flood is prevented with levees while securing egg-laying sites of sweetfishes and conserving a river environment suitable for cormorant fishing.

22.5.2.2 Enhanced Flood Control Function

Enhancement of flood control functions includes the development of dams, discharge channels, flood control basins, etc. Regarding this issue, CRDB of MLIT has concluded that the development of dams and discharge channels is difficult because the amount of suitable land is insufficient and urban development has advanced in this area. Consequently, regulating land use in expected flood areas while maintaining the current open levee structure should be effective to develop a flood control basin. In addition, disaster dangerous zones should be designated after taking countermeasures against flood damage on existing residential housing lands:

- Dams: Although existing and under-construction dams (Atagi Dam and Uchigatani Dam) are incapable of providing sufficient flood control effects, construction of additional dams is difficult due to lack of suitable sites and the financial burden.
- Discharge channels: In case of floods around Gifu City, which has potential flood risks, construction of new channels (discharge channels) to bypass flood flows

into other rivers (or downstream of the Nagara River) is unrealistic, considering the current situation of urbanization.

- Flood control basins:
  - The development of flood control basins by constructing overflow levees for the main stream and main levees for expected flood areas should promote the development of flood control basins and countermeasures for expected flood areas.
  - Conservation of flood control functions should sustain flood control functions and deal with development pressure until flood control basins are developed.

22.5.3 Flood Disaster Mitigation Using a Flood Control Basin

In the middle basin of the Nagara River, flood disaster mitigation using flood control basins is realistic. Because securing a flood control basin is relatively easy, it may be an effective measure. However, relocating buildings necessary to secure basin sites requires time and money. Hence, if flood control basins already exist and developing additional ones are unnecessary, conserving the current flood control basins as much as possible is very effective.

- Advantages of a flood control basin:
  - It allows planned land use because a flood control basin defines the range of flood plain.
  - It mitigates flood damage in areas outside of the flood control basin.
  - It can be utilized for more than just a flood if certain restrictions are adhered to.

- Disadvantages of a flood control basin:
  - In a flood control basin, land use that lowers its flood control function (e.g., construction of buildings that have a structure preventing flood control functions) is regulated because the flood control functions must be maintained.
  - Relocation of existing buildings within the flood control basin sites may be necessary.

22.5.4 Policy of Flood Disaster Mitigation Measures in the Basin of the Nagara River

The flood control measures for the Nagara River are basically a combination of small-scale dams with flood control functions because geological restrictions inhibit suitable sites for large-scale dams. The disadvantages of setting back a levee and raising banks prevent either from being a realistic option. Thus, utilization of the flood control function should be the most suitable measure for this area.

Measures to secure flood control functions include development of a flood control basin and conservation of current flood control functions. However, a large quantity of land must first be purchased to develop a flood control basin, which is a significant obstacle.

The middle basin of the Nagara River has played an important role in flood control and has contributed to the mitigation of flood damages in areas around the midstream and downstream because the physical features of the middle basin provide flood control functions. Considering the population and assets accumulated in the floodplain of the midstream and downstream as well as the history of flood prevention policy on this river, maintaining and continuing to secure flood control functions is a practical solution. Consequently, agricultural lands play an especially important role.

22.6 Conclusion

Although flood risks have increased, the budget allocated for flood control projects and flood disaster mitigation measures is limited. In addition, it is difficult to construct large-scale infrastructure in urbanized areas. Thus, in urban areas, effective flood control and mitigation measures must combine various measures while developing infrastructure. This study examines flood risk control from the perspectives of regional development and land use with an emphasis on utilization of existing flood control functions as a flood disaster mitigation measure.

Land use plays an important role in flood risk control. Development without sufficient consideration of flood risks increases the potential flood risks. In addition, the loss of agricultural lands, which have flood control functions, decreases the ability to mitigate flood risks. Consequently, land use along with infrastructure should be considered for flood control.

Ideally, specific measures, such as conservation of agricultural lands, should be integrated into master plans regarding city planning or land use. Because development should be guided with consideration of flood risks, city planning techniques should suppress deregulated development while regulating the conversion of agricultural land into nonagricultural lands.

As described above, it is crucial that land use control is integrated into flood control across the whole basin. Thus, the challenge becomes developing comprehensive policies and plans on flood risk control and land use in cooperation between different departments responsible for city planning, agriculture, and river control. In addition, flood disaster mitigation measures on the river must be considered based on a basin, which means multiple municipalities and prefectures must collaborate. Successful flood risk control depends on the effective coordination among these plans and organizations.

Even though Japan whose population has decreased since 2008 (Statistics Bureau 2015), there is still pressure for development locally. It is easily assumed that land development pressure is stronger in countries which are experiencing high economic growth. The population in rural and urban area will continue to increase in developing countries, and the increase in urban area is expected to exceed the one of rural area in 2020 (Earth Trends 2008). It is seen that urban and suburban areas are spread to show sprawl phenomena creating disorder land use for residential and industrial developments (The World Bank 2008, 2015).

Developments and conservation of natural environments have to be balanced; otherwise, the unbalanced situation can create disaster. Disaster risk reduction can play an important role to balance them by mitigating and avoiding disaster risk. Land use planning is a key to mitigate or avoid risks through appropriate land use practices. As stated in Hyogo Framework for Action 2005–2015 and Sendai Framework for Disaster Risk Reduction 2015–2030 (United Nations Office for Disaster Risk Reduction 2015), land use management is one of the important measures for disaster risk reduction, and growth management to control development through land use planning is definitely a way to cooperate with nature (Burby 1998; Catlin 1997).

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Chapter 23
River Basin and Land Use Lessons from Bangkok, Thailand

Wijitbusaba Ann Marome

Abstract The urban development of Bangkok has focused on the promotion of internal economic growth and citizen's livelihood such as that found in many cities of the Global South. Infrastructure development and economic development have always been the center of Bangkok's urban development policy and planning. As a result, incorporating the possible risks that could occur from the impacts of climate change into its urban development policies has sometimes been overlooked.

In the past decade, the city has changed from a compact urban core into a metropolis. Bangkok acts as Thailand's political, economic, and administrative capital, but has also risen into a regional and global hub. Geographically, the city has extended from its original downtown area to incorporate its five neighboring provinces to form a single agglomeration. Bangkok is the largest city within Thailand, where approximately 15 % of the country's population resides in the Bangkok Metropolitan Region. Despite the city's economic and demographic vibrancy, Bangkok is highly disposed to climate change and various environmental issues. The city is susceptible to inundation as, geographically, the city lies on low-lying planes of 1.0–2.0 m and regularly receives water from runoff, rain, and seawater.

Thailand often uses the comprehensive plan as a land management tool in conjunction with the city planning code for land utilization. The aim of the comprehensive plan and its regulatory framework is solely to limit urban development.

(A) Parts of this book chapter were used as a background paper prepared for the Global Assessment Report on Disaster Risk Reduction 2013. UNISDR. Geneva, Switzerland. Cited in Marome, W.A., 2012. *Private Sector Investment Decisions in Building and Construction: Increasing, Managing, and Transferring Risks: A Case Study of Thailand.* Geneva, Switzerland: UNISDR.

(B) This book chapter is part of the research called "Coastal Cities at Risk: Building Adaptive Capacity to Managing Climate Change in Coastal Megacities." Case studies are Vancouver, Manila, Lagos, and Bangkok. The research was carried out with the aid of a grant from the International Development Research Centre (IDRC), the Canadian Institute of Health Research (CIHR), the Natural Sciences and Engineering Research Council of Canada (NSERC), and the Social Sciences and Humanities Research Council of Canada (SSHRC), Ottawa, Canada.

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However, the excessive bulk of regulations, lack of enforcement efficiency, and improper use of future land use mapping for zoning have deemed the comprehensive plan ineffective.

Land management in Thailand uses three main mechanisms: planning, regulation, and fiscal mechanisms. The limitation of Thailand's current urban planning systems will be the main discussion of this chapter. It was found that land use planning does not coincide with the changing environmental and socioeconomic conditions. A comparison will also be made between the land use change map and the flood maps.

Keywords Land use planning • Flood • Urban development • Bangkok

23.1 Introduction

In order to control the urban development, the comprehensive plan is used as a land management tool alongside the city's land use planning codes. It was considered as ineffective due to abundant regulations and inefficient enforcement, which were further worsened by the inadequate use of future land use maps for zoning.

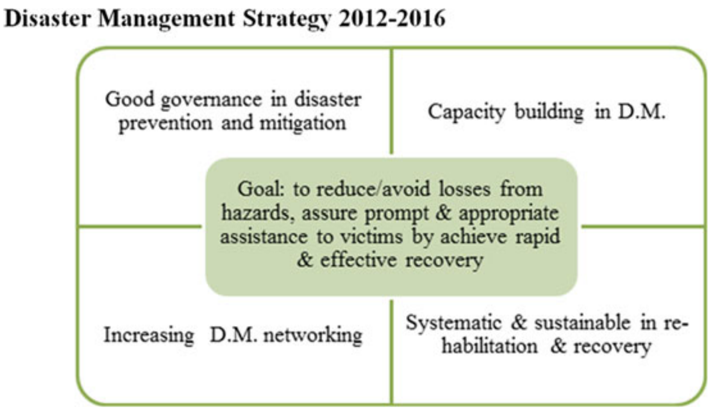
Planning, regulation, and fiscal mechanisms are the three main instruments used in Thailand's land management. Within planning, zoning is conducted through colored maps which differentiate land into areas for residential, commercial, agricultural, cargo, conservation, and floodway. The colors are further divided by various densities and land use requirements. Large zones may encompass smaller communities and neighborhoods that exhibit different land use patterns. In the area of land legislation, the important legal instruments used are zoning ordinance, floor area ratio, and open space ratio. These act as an expansive control framework but are not blueprints for urban development. Lastly, the potential of fiscal mechanisms in reshaping land use is not fully realized and often underutilized. Levies, such as the already implemented local development tax and housing and land tax, are not being effectively put in place to generate the land usage outcome goals (Srisawalak-Nabangchang and Wonghanchao 2000). The positive development is the publication of Bangkok's 2006 Comprehensive Plans. It provides a long overdue progression for Thailand regarding the creation of clear frameworks for the development of the nation's cities, which incorporated detailed guidelines and specifications such as spatial ratios and plot size.

However, undesirable or conflicting land usage can occur due to the preexisting development and the inadequate success of the new controls. The inefficient and disintegrated controls on urban planning and land use means that private construction and real estate are economically driven by short-term financial gain, profit, and speculation. The devastating 2011 flood has emphasized the cost of inappropriate and inconsistent land use development, such as obstructing natural flood drainage systems.

23.2 Disaster and Risk Management: The Public Sector Response

The Department of Disaster Prevention and Mitigation (DDPM), under the Ministry of Interior, is the main agency responsible for managing disasters in Thailand. The DDPM and local municipalities work alongside each other. As regards disaster risk assessment, there is no single agency or mechanism that oversees the process. The assessments are carried out by various government agencies, with the DDPM acting as a supervisory body. There are numerous projects and activities to prepare citizens for future disasters, such as trainings, drills, and exercises, recruiting volunteers, and awareness-raising campaigns. A crucial point to consider is the 2012–2016 disaster management strategy, which prioritized immediate disaster response and relief. On the other hand, post-disaster management needs assessment, victim support networks, sanitary measures, recovery assistance, financial mechanisms, basic infrastructure restoration, and other tools.

23.3 Disaster Management Strategy 2012–2016



Source: Adapted from Department of Disaster Prevention and Mitigation (Paksuchon 2010)

The main mandate of DDPM at the national level is to propose the policy to formulate the National Disaster Prevention and Mitigation plan and determine and preapprove the plan under Section 11(1) before submitting the plan to the Cabinet. At the local level, the main responsibility of DDPM is to integrate the development on disaster prevention and mitigation mechanisms among government agencies, local administrations, and other relevant private sectors effectively (Disaster Prevention and Mitigation Act, B.E. 2550, 2007). In other words, the emphasis of DDPM's roles has been weighted heavily on short- to medium-term disaster relief and response. Long-term recovery has solely focused on formulating the national disaster plan and providing support and promotes any disaster prevention and mitigation activities. Hence, DDPM has no direct legislative power to control urban growth and development, and land use planning at both the national and local level, as a long-term measure of flood and disaster mitigation. Disaster concerns, which extend further than relief to adaptation and resilience, are heavily reliant on Thailand's urban planning system's capacity to deliver long-term improvements.

23.4 Natural Hazards

The definition of "natural hazards" is the potential, experience, and repercussion of environmental extremes. The term "hazard" must be differentiated from "natural disasters" as it exclusively refers to an actual extreme occurrence. Additionally, the term "natural" cannot be realized as a natural hazard as it has components of human involvement. In areas where there are no human interests, natural extremes cannot be regarded as a hazard. Sequentially, a hazardous occurrence that results in large-scale casualties is considered a disaster. Hazard that can be transformed into a disaster is dependent on how a society is organized. Human systems put some people more at risk; a relationship is defined by vulnerability of individuals, households, communities, or societies. Vulnerable populations are at risk not only to exposure to hazards but also because of societal structures of age, gender, class, ethnicity, or disability that have made these populations marginal (Bankoff 2010).

In 2011, Thailand was struck by the worst flood disaster in over 50 years which resulted in devastating social and economic implications for the nation. The flood covered over two-thirds of the country, covering approximately 90 billion square kilometers. Thailand's 2011 flood occurrence has become known as the world's most costly natural disaster (Hydro and Agro Informatics Institute 2012). The industrial sector was not spared, where the seven industrial estates in the provinces of Ayutthaya and Pathum Thani alone experienced damage to almost 1000 factories and over 700 billion baht in insurance claims. In December 2011, a preliminary estimate by the World Bank valued the damages and loss at THB 1,425 Bn ($ 45.7 Bn), with approximately $ 32 Bn in the manufacturing sector alone (World Bank 2011).

The crisis was a result of extraordinary combination of natural factors, months of unprecedented rainfall, and to some extent man-made. The aftermath has forced the nation to tackle the painful lessons derived from the limitations from their urban and environmental planning approach. Many solutions to the aforementioned limitations come from the increased cooperation between the public and private sector. Additionally, regulation of future urban development incorporates the recognition that natural vulnerability must be respected to ensure mutual benefits between Thailand's economy and its environment.

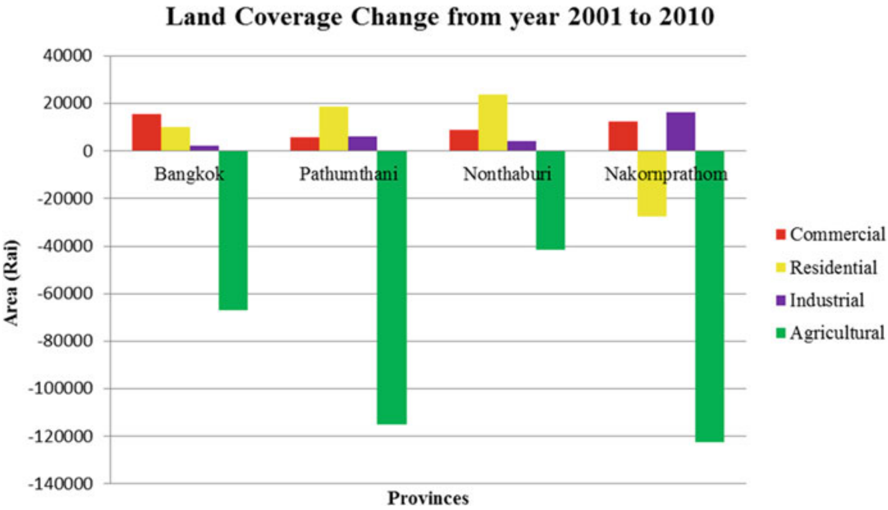
23.5 Land Usage Change and the Limitation of Land Use Policy

Thailand's comprehensive plan is utilized as a land management instrument in conjunction with the city planning code on land usage. The comprehensive plan and its regulatory family are goaled at controlling urban development. However, the plan is considered ineffective because of the volume of regulations and inadequate enforcement, which are further worsened by the inadequate implementation of future land use zoning map. Land management uses three tools: planning, regulation, and fiscal instruments. Within planning, zoning is displayed through colored maps that segregate land into residential, commercial, agricultural, industrial, cargo, conservation and floodway areas. The colors are further divided into different densities and land use requirements. However, the zones and blocks tend to cover large areas. Small communities and neighborhoods with different land use patterns can be incorporated into one large zone. Regarding legal mechanisms, important landmarks in land registration include the zoning ordinance, floor area ratio, and open space ratio. These act as a large control structure, but are not blueprints for urban development. Lastly, fiscal tools remain underutilized as a means to reshape land use. The levies that have been put in place, such as the local development tax and the housing and land tax, are not effectively utilized to produce the targeted land use outcomes (Srisawalak-Nabangchang and Wonghanchao 2000). A positive development in recent years is the publication of Bangkok's 2013 Comprehensive Plan.

The occurrence of a disaster is one aspect that causes land use policy within an area to change. The government's land management policies, such as the 2013 Comprehensive Plan, have set the eastern areas of Bangkok such as Minburi and Khlong Samwa and the western districts of Taling Chan and Bangkae as the conversation and agricultural land type 1 to type 3. A majority of land use should be indicated as green areas in order to promote the absorption and receive water and coincide with Bangkok's 2013 Comprehensive Plan. If the land has been utilized in a different manner, it may have a serious impact on people living in the area during severe disasters. An example of such incidents can be observed within the Taling Chan district which have been a rural conservation and agricultural area (type 2) and Taweewattana district which was set as a rural and agricultural area (type 4). If there were constructions of residential buildings within the area, such as twin houses, row houses, or row buildings in large quantities, these buildings would be largely affected during severe floods from water released from the west.

While Bangkok has a strong potential adaptive capacity, its urban planning system may nevertheless find that it fails to keep pace with the increasing threat and exposure brought about by climate change and rapid population growth. For

Table 23.1 Land coverage change of Bangkok, Pathum Thani, Pathumthani, and Nakhon Pathom provinces from year 2001 to 2010



Source: Department of Public Works and Town & Country Planning, 2001 and 2010

decades, what regulation has been put in place has frequently been sabotaged, ignored, or circumvented. One example, back in 1992, is the BMA's belated planning restrictions in the eastern floodplain, with detailed zoning for landfills and housing. Had these regulations been observed, it is likely that the eastern area of Bangkok would have retained more of its natural capacity as a floodway, and the destruction inflicted by the 2011 flooding would have been substantially lower. Yet in practice, the code was widely ignored. Bangkok also has a system of "green diagonal" zoning in areas of Khlong Samwa, Minburi, Ladkrabang, and Nong Chok, where the construction of most property types is prohibited and limited to single houses on a plot of 1,000 wah. Regulations also impose a minimum of 100 wah for houses in certain areas to the west of the city. This is intended to benefit farmers and provide them with the land they need for cultivation. However, through a legal loophole, the regulations have been exploited to facilitate the construction of luxury housing in areas such as Thonburi, in western Bangkok.

Due to the preexisting development and limited effectiveness of the new controls, undesirable or conflicting land usage can occur. The inefficient and incomprehensive controls for urban planning and land use have resulted in private construction and real estate that are propelled by short-term economic gain, profit, and speculation. The 2011 flooding has emphasized the cost of inadequate and inconsistent land use development, for example, obstruction of natural flood drainage systems.

The table below (Table 23.1) represents land use trends between 2001 and 2010. It is crucial to highlight that within Bangkok and its periphery provinces, agricultural land has been converted to other land uses, particularly in Pathum Thani. In all cities, land developments for residential areas are increased, except Nakhon Pathom Province.

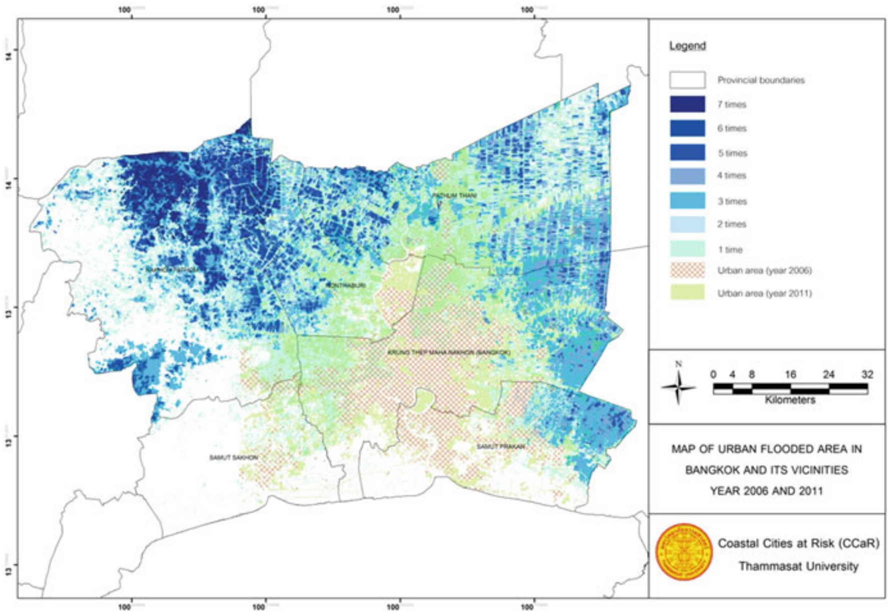
The above analysis also provides measurements on the physical impacts of past serious occurrences of flooding in 2006 and 2011. The 2011 flooding is one of the most devastating floods that Thailand has experienced, with both social and economic implications on the nation. The flood covered approximately 90 billion square meters, which amounts to around two-thirds of the country. It proved to be the world's fourth most costly disaster (Hydro and Agro Informatics Institute 2012). The industrial sector also suffered significant damage from the flood. Across seven industrial estates in Ayutthaya and Pathum Thani, almost 1000 factories have been damaged and over THB 700 billion in insurance claims. In a World Bank estimate in December 2011, the total economic losses and damages were estimated at THB 1425 bn ($ 45.7 bn), where up to $ 32 bn were suffered in the manufacturing sector alone (World Bank 2011).

The crisis was a result of a combination of natural factors, unprecedented rainfall, and to a certain extent, man-made. Thailand was faced with painful lessons resulting from the limitations of its current urban and environmental planning. The solutions for these limitations can be found through increased cooperation between the private and public sectors. In order to regulate future urban development, natural vulnerability must be respected for the common good of the nation's environment and the economy.

This analysis covers a total inundated area in Bangkok Metropolitan Region (BMR) because the flooding in 2006 and 2011 covers different land use types. This is summarized in the data provided by the Geo-Informatics and Space Technology Development agency (GISTDA) and is represented in the figures and maps below. The results indicated that within Bangkok, agricultural land within the four districts located outside Bangkok's inner protection strategy, Nongjork, Khlong Samwa, Ladkrabang, and Minburi, is prone to flooding. These areas are initially planned to be floodplains; however, as a consequence of rapid urbanization and land use change, the agricultural and floodplain areas in these districts were converted to residential and industrial developments. This is supported by the increasing rates of affected residential and commercial areas in floodplains in 2011, where rates far exceed those estimated in 2006. Additionally, water storage and evapotranspiration capacity were further reduced due to upstream deforestation by >50 % (from >60,000 to <30,000 mcm). Almost all natural water retention areas (such as swamps, wetlands, etc.) and natural floodways were converted to agricultural and urbanization areas (Snidvongs 2012).

The table below (Table 23.2) represents repetitive inundated areas of 2006 and 2011 flooding which is also classified by different land use type of Bangkok Metropolitan Region or BMR. It is crucial to highlight that in the northern part of BMR including Nonthaburi, Nakhon Pathom, and Pathum Thani provinces, the majority of these areas had been flooded between four and seven times during 2006–2011. Nonetheless, most of the land use in these areas is agricultural and residential areas. This suggests the limitation of land use system and its control

Table 23.2 Repetitive inundated areas of 2006 and 2011 flooding classified by different land use types of BMR



Flood data: RADARSTAT-2, GISTDA, 2005–2013
Urban area 2006: Landsat 5 (resolution 30 m)
Urban area 2011: Thoes (resolution 2 m)
Land use data: Department of Public Works and Town & Country Planning

mechanism in Thailand. Moreover, residential areas have expanded to the flood-prone areas.

Despite the large investments made in the past 30 years on flood protections, Bangkok's flood management system may be inadequate to cope with future flood risks. During the 2011 flood, reports have indicated that the system was unable to properly cope with the large amounts of runoff water flowing in from the north. According to former officials, the infrastructure was initially made to cope with localized flooding caused by rainfall (Bangkok Post 2011). Additionally, the King's dyke has been designed to receive low-level flooding rather than the large-scale floods experienced in 2011 (IRIN 2011). Considering the effects of climate change, land subsidence and other factors, planned and existing dams, and drainage systems may be inadequate in protecting flood-vulnerable areas from a once-in-a-decade flooding disasters, such as the flood-prone western districts of Bangkok (World Bank 2009). Although Bangkok's adaptive capacities are relatively strong, it may be unable to pace itself against the increasing threats and exposure caused by climate change and increasing rates of population growth (Yusuf and Francisco 2009).

There are two main types of industrial land use, of which consists of different requirements relative to environmental planning. Land type A is manufacturing industries with low productions of pollution. Land type B is heavy-pollution productions and is defined by law as industrial parklands.

Industrial parks are the most visible confluences between industrial development and urban planning in Thailand. There are a total of 42 estates across the country. These estates are located within specially designated zones set by the Ministry of Industry, where they are subsequently developed by private sector investors and partners. With the minimum size of approximately 500 Rai (around 0.8 km^2), 60–70 % has been designated for factories. These estates consist of all the infrastructures of a typical city, where most importantly also includes a flood protection system (Supatn 2011).

The development of the industrial estates is bounded by some degree of government regulations. The Industrial Estate Authority of Thailand (IEAT) requires that the industrial sector chooses an area appropriate to their activities, where estates are located in low-lying planes and a polder taller than 50 cm and would be able to withstand a devastating flood occurrence. However, industrial flood mitigation is often highly dependent on infrastructural prevention, which have been designed around past flood situations and limited return periods which can be irrelevant during extreme flooding situations in the future.

Environmental Impact Assessment (EIAs) and other forms of assessments attempt to highlight possible adverse impacts and guide development of appropriate mitigation systems. An example is the requirement of industrial operators that test wastewater to determine if the discharge volume remains within an agreed limit, which ensures that they still abide by the terms set within the Factory and Building Act (United Nation 2005). Despite such assessment systems, the issues of wastewater pollution still exist.

Studies on the dispersion of the city show increasing rates of expansion to the outer areas. The expansion is often found in the form of basic infrastructure, such as roads, in order to increase convenience and improve daily life for citizens. However, this is carried out without the consideration of risks caused by disaster, which can have wide-ranging, direct impacts on citizen's daily life as well.

Due to increasing rates of inner migration and growth rates of cities, this resulted in the expansion of residential and commercial areas into vicinities prone to disaster risks. This increases the trends and severity of losses caused by disasters, as well as amplifying the complexity of coping measures. Therefore, the system to manage and plan cities must be robust in order to control and cope with the existing and future risks. This includes access to information, since it will improve the citizen's capacity to cope while they become more aware of risks.

23.6 Conclusion

The 2011 flood has highlighted that natural protection, other than as a moral responsibility, is an intricate aspect of business risk that must be considered as a primary point in the industrial sector's strategy to reduce vulnerability. The government and the private business both play an important role in achieving this.

An approach to reduce risks is to **decrease the sensitivity of Thailand's urban planning system**, where disaster risk must be factored into its code and regulations. The government has to set clear and enforceable guidelines to allow positive future outcomes in urban development, particularly the growth of industrials, as well as for communities, businesses, and the environment.

Urban planning has a direct relationship with citizens. Clusters of Bangkok's population are gathered within the central areas of the city and gradually disperse and lessen within the suburban areas. With the expansion of the population, with greater density in the northern areas of Bangkok and Pathum Thani Province, urban planning must consider the direction of the expansion of the population as well. When the population is clustered within downtown areas and the northern city outskirts, disaster mitigation management must try to minimize the impact to the city people.

The government should also **develop solid economic structures for tax incentives**, estimating the cost of effect in risk reduction relative to infrastructure and construction investments which could later facilitate negotiations about premiums and coverage with the insurance sector. Imposing effective controls for water management and other environment practices on companies, the government can ensure a rise in confidence among insurance firms toward Thailand's industrial sector and promote lower insurance costs for companies in the medium term.

Lastly, **information and data on flooding should be readily available** by the government and effectively disseminated by the private sectors among national and foreign companies and facilitate decision-making. As a result businesses can take a more informed approach to reducing future environmental risks, which will benefit them financially and bring considerable advantages to local communities and the environment.

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