A Workbook on Planning for Urban Resilience in the Face of Disasters

Adapting Experiences from Vietnam's Cities for Other Cities

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Fatima Shah and Federica Ranghieri

THE WORLD BANK
Washington, D.C.

1818 H Street NW
Washington DC 20433
Telephone: 202-473-1000
Internet: www.worldbank.org

1 2 3 4 15 14 13 12

ISBN (paper): 978-0-8213-8878-5
ISBN (electronic): 978-0-8213-8939-3
DOI: 10.1596/978-0-8213-8878-5

Library of Congress Cataloging-in-Publication Data has been applied for.

Editing and internal design and layout by Nita Congress. Cover design by Drew Fasick.

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Foreword

The world is urbanizing rapidly. A little over half the global population is urban today. According to the United Nations Human Settlements Programme (UN–HABITAT), by 2050, this proportion will grow to 70 percent—and of a much larger pie, 9 billion people worldwide. This urban growth will predominantly (90 percent) take place in developing countries. Developing countries host 70 million new urban residents each year. Cities in the developing world are already challenged in providing adequate infrastructure and services to current residents, let alone supporting such large increases in the future. It is expected that the global slum population will double to 2 billion by 2030.

The trend in increasing natural hazards further complicates the situation. The Centre for Research on the Epidemiology of Disasters reports via its Emergency Events Database (CRED EM-DAT) that, in 2010, 385 natural disasters killed nearly 300,000 people, affected over 217 million others, and caused $123.9 billion in damages in 131 countries. These economic damages represent an increase of 160.4 percent compared to 2009. Climate change and shifting tectonic plates will further exacerbate the situation. A recent World Bank study projected that, by 2050, large cities exposed to cyclones and earthquakes will more than double their population to 1.5 billion, primarily as a result of population increase. According to a study of 136 port cities around the world conducted by the Organisation for Economic Co-operation and Development, assets exposed in these cities to the potential impacts of climate change could grow from $3 trillion to $35 trillion by 2070.

East Asia is 48 percent urban today and, with 2 million new residents migrating to cities every month, will become mostly urban by 2013. Urbanization is so rapid that built-up areas are projected to increase more rapidly here than in any other region in the next 20 years. Still, more than half of the world's slum dwellers live in East Asia. These are the people most vulnerable to disaster impacts because they tend to live on environmentally fragile land, rely for their livelihood on sectors that are especially prone to devastation, and do not have adequate savings to recover from disasters. Given that Asia accounted for more than a third of all reported disasters in 2010, and that natural disasters have quadrupled in the region during the past 20 years—the fastest rate of increase for any region in the world—managing urban growth for resilience is increasingly important.

Greater efforts are clearly needed in disaster risk reduction, including climate adaptation. Much of this must be done at the local level, where the impacts of disasters are experienced. For this reason, the World Bank's *Climate Resilient Cities: A Primer on Reducing Vulnerabilities to Disasters* provided guidance to governments in the East Asia region, and beyond, on the concepts of climate change and disaster risk reduction, how climate change consequences contribute to urban vulnerabilities, and what is being done by city governments around the world to actively engage in capacity building and capital investment programs for building resilient communities.

This workbook is a natural extension of that primer and is based on a program of technical assistance provided to three cities in Vietnam—Can Tho, Dong Hoi, and Hanoi—that undertook the development of local resilience action plans (LRAPs). These plans will enable communities to identify vulnerabilities to current and future natural disasters and take specific steps to reduce those vulnerabilities. Vietnam loses 1.5 percent of its gross domestic product each year to typhoons, landslides, and floods; it is projected to be hard hit by increases in sea level, precipitation, and temperatures associated with climate change. But cities are starting to take steps to reduce their vulnerability. Using the information at their disposal, they are framing comprehensive strategies that include infrastructure responses, public awareness initiatives, and early warning systems. The LRAPs include both structural and nonstructural measures and have been undertaken in coordination with many agencies at the city level; they have also been based on a collaborative process with research communities and consultation with stakeholders.

This workbook provides standard procedures local officials can use to develop LRAPs. While based on learning from the Vietnam experience, the guidance provided can be applied by any city at any level of disaster preparedness. The experience of the three pilot cities is the basis for illustrating the methodology. The pilots represent a broad range of city characteristics in terms of geography, population size, economic base, administrative structure, and natural hazards—demonstrating that the LRAP process is useful to a variety of cities. Indeed, the methodology has been taken up by cities outside of Vietnam, in China, Indonesia, and the Philippines. These cities have adapted the steps in the workbook to fit their local conditions and priorities.

We encourage other cities to embark on the LRAP process and plan for managing current and future disaster risk, keeping in mind that sometimes the best resilience measures are aimed at overall development. For instance, providing better housing, access to water and sanitation, improved nutrition and health care, and diversified sources of income can increase resilience. Similarly, clearing the infrastructure deficit and providing greater resources to operations and maintenance can have exponential benefits.

This workbook forms a core part of the curriculum for the World Bank Institute e-Learning course on Safe and Resilient Cities. This course helps cohorts of city practitioners develop their own LRAPs through a guided process in identification of risks, measures to mitigate these risks, prioritization, and implementation plans.

Increased hazard risk does not have to increase damage and losses, provided that factors contributing to vulnerabilities can be better managed. Actively preparing for disasters and undertaking preventive measures to reduce impacts can have a big pay-off. Research shows that for every $1 spent on disaster risk reduction, $7 is saved in response and recovery. International aid after the occurrence of disasters represents nearly one-fifth of total humanitarian aid, while the share for prevention is less than 1 percent. We hope that this workbook, and the course that stems from it, can help move the dialogue to reversing this trend.

John Roome
Director
East Asia Sustainable Development
World Bank

Bruno Laporte
Director
Knowledge and Learning
World Bank Institute

Acknowledgments

This workbook is the result of the World Bank's Vietnam Climate Resilient Cities technical assistance project. It was prepared in consultation with the Vietnam Ministry of Agriculture and Rural Development (MARD) and Minstry of Natural Resources and Environment (MONRE). The team would particularly like to acknowledge MARD Vice Minister Dao Xuan Hoc, Deputy Director General Nguyen Xuan Dieu at the Directorate of Water Resources (MARD), and Director Tran Thuc and Deputy Director Nguyen Van Thang at the Institute of Meteorology, Hydrology and Environment (MONRE).

The project was led by Fatima Shah, Special Assistant to the Vice President for Sustainable Development, the World Bank. Fatima Shah and Federica Ranghieri, Senior Urban Specialist with the World Bank Institute, prepared this workbook. Background inputs were provided by Hyoung Wang, Urban Economist at the World Bank, and a number of consultants, including John Felton, Ravi Sinha, and the Geoville Group.

City-level action plans in Can Tho, Dong Hoi, and Hanoi, Vietnam, were the field cases on which the guidance in this workbook is based. The following persons are particularly acknowledged for their pioneering efforts in this regard:

- In Can Tho, Nguyen Thanh Son, Chairman of the People's Committee and Head of the Steering Committee on Climate Change (SCCC); Duong Ba Dien, former Director, Department of Environment and Natural Resources, and Standing Vice Head of SCCC; Pham van Quynh, Director,

Department of Agriculture, and Vice Head of SCCC; Ky Quang Vinh, Director, Can Tho Center for Natural Resource and Environment Monitoring, and Secretary of SCCC; and all the members of the Can Tho SCCC and its Working Group.

- In Dong Hoi, Tran Dinh Dinh, Chairman of the People's Committee; and all the members of the Dong Hoi SCCC and its Working Group.
- In Hanoi, Nguyen Van Khoi, Vice Chairman of the People's Committee; Pham Van Khanh, Deputy Director, Department of Environment and Natural Resources, and Head of Climate Change Working Group; Dao Duc Tam, Deputy Director, Department of Agriculture, and Vice Head of Climate Change Working Group; and all the members of the Hanoi SCCC and its Working Group.

Financial support for the development and printing of this workbook is gratefully acknowledged from the Korean Trust Fund (project on Good Practices in Urban Environment Management), the Italian Trust Fund on Carbon Finance and Climate Change, and the Australian Aid Agency's (AusAID's) Infrastructure for Growth Trust Fund (project on Knowledge Partnerships) for supporting World Bank staff time and travel. We are grateful to GFDRR's Hazard Risk Mitigation Institutional Development (Advocacy and Capacity Building Program in Viet Nam 2007–2009) for supporting consultant time and travel as well as in-country stakeholder workshops.

The Global Facility for Disaster Reduction and Recovery (GFDRR) is a partnership of 38 countries and 7 international organization committed to helping disaster-prone developing countries and regions reduce their vulnerability to natural hazards and adapt to climate change. GFDRR promotes technical and financial assistance to high-risk low- and middle-income countries based on a business model of ex-ante support to mainstream disaster risk reduction in national development strategies and investments, and ex-post disaster assistance for sustainable recovery. As part of its mandate, GFDRR promotes global knowledge and good practices, supports initiatives for enhanced global and regional cooperation, and promotes greater South-South cooperation in disaster risk reduction. www.gfdrr.org.

About the Authors

FATIMA SHAH is the Special Assistant to the Vice President for Sustainable Development, the World Bank. She was previously a Senior Urban Economist with the World Bank's East Asia Region, where her work focused on urban development, including urban poverty, land use, disaster risk management, and infrastructure investments in China, Indonesia, the Philippines, Thailand, and Vietnam. Prior to that assignment, she was a Private Sector Development Specialist at the World Bank–IFC Foreign Investment Advisory Service, where she advised the governments of Bangladesh, Egypt, Nepal, and Pakistan. She has been with the World Bank for more than nine years. She holds a B.A. from Smith College, an M.Sc. from Oxford University, and an M.P.P. from the University of Chicago.

FEDERICA RANGHIERI is a Senior Urban Specialist at the World Bank. She joined the World Bank in 2004 with the Carbon Finance Business Unit, where she developed the Italian Carbon Fund. Since 2007 she has worked with East Asia Sustainable Development on climate change, mitigation, and adaptation policies, and disaster risk management, with a particular focus on China, Indonesia, Thailand, and Vietnam. She coordinated the Disaster Risk Management and Climate Change Adaptation Program at the urban level at the World Bank Institute. Before joining the World Bank, she was an assistant professor at the University of Milan, where she taught classes on environmental policies and environmental and social communication. She holds a *laurea* in economic

and social studies from Bocconi University, Milan, and an M.A. in international studies from American University, Washington, D.C.

Executive Summary

This workbook is intended to help policy makers in developing countries plan for a safer future in urban areas in the face of natural disasters and the consequences of climate change. It is based on the experiences of three cities in Vietnam—Can Tho, Dong Hoi, and Hanoi—that worked with international and local experts under World Bank supervision to develop local resilience action plans (LRAPs) in 2009–10. An LRAP is a detailed planning document that reflects local concerns and priorities based on the experiences of the past and projections for the future. It is not a wish list of projects that may never be completed because they are too costly or lack political support. Rather, it should be a realistic document that describes and establishes priorities for specific steps that can be undertaken in the near term to adapt to both climate-related and other hazards.

Regardless of their size, location, political orientation, or technical capacity, other cities can learn from the experiences of these pilot cities to develop their own LRAPs. The purpose of this workbook is to adapt the initial experiences of Can Tho, Dong Hoi, and Hanoi to benefit the national government and other communities in Vietnam and beyond. Indeed, the process described in this workbook was later adopted in the cities of Iloilo, the Philippines; Ningbo, China; and Yogyakarta, Indonesia—and the concluding chapter of this workbook draws on some of the lessons learned in these cities. However, the workbook, while generalizable to other contexts, largely reflects the Vietnamese experience.

Climate change will have varying impacts around the world in terms of changing temperatures, precipitation patterns, sea level rise, and an increase in extreme events. In Vietnam, in particular, increases in the intensity and frequency of typhoons and tropical storms are expected to cause increased flooding in the coming years. In addition, rising sea levels likely will expose low-lying areas in Vietnam—including much of the coastline and the Mekong and Red River Deltas—to a significant risk of permanent inundation. The three pilot cities in Vietnam have diverse geographies, sizes, and needs—and each is highly vulnerable to natural disasters and the consequences of climate change. Hanoi, a large city, is the national capital located on the banks of the Red River. Can Tho is a medium-size city located in the vast Mekong River Delta. Dong

Reader's Guide

This workbook provides a user-friendly, step-by-step approach for national, provincial, and local governments to use in meeting the challenges posed by natural disasters and the potential impacts of climate change. These steps are meant to build on one another rather than offer discrete outputs at the end of each step. Cities can customize steps based on their prior planning (to limit duplication) and capacity; some cities may wish to undertake more rigorous assessment in particular steps.

Chapter 1 sets the context in terms of global disaster trends and expected climate change, before focusing on the specific risks faced by Vietnam. It offers an overview of current government policies in Vietnam and describes, in general terms, how national and local governments can take proactive measures to make their citizens and communities safer. It summarizes the characteristics of the three pilot cities and how their experiences are relevant for other communities in Vietnam and beyond.

Chapter 2 provides an easy-to-understand explanation of a local resilience action plan as a strategic action plan for short-, medium-, and long-term structural and nonstructural measures designed to increase a city's resilience. The chapter takes the reader through an overview of the step-by-step process of risk identification and assessment leading toward the creation of the LRAP.

The heart of the workbook is a series of chapters that detail the specific phases and steps in the LRAP process. The first set of steps, in **chapter 3**, entail sensitization—raising awareness and generating support for the resilience planning process. An essential aspect of this phase is raising community awareness of the need for action and generating broad support for the planning process.

A second crucial phase in the LRAP process is identifying the specific vulnerabilities the community faces. This technical analysis, detailed in **chapter 4**, involves preparing a series of maps to provide a visual presentation of the hazards to the city's people, infrastructure, and economy, now and in the future. One set of maps will illustrate vulnerabilities at the citywide level; another will address future vulnerabilities at the neighborhood and community levels, focusing primarily on those areas that are most vulnerable. For more technically advanced cities, the chapter includes information on pushing the analysis to a higher level, taking into account downscaled climate projections and layering through geographic information system (GIS) formats. For smaller

Hoi is a small city (and a provincial capital) located on the central coast of the South China Sea.

While national- and city-level policy makers cannot alter the increasing hazard risks that urban areas will face—including those associated with climate change—they can work with stakeholders to plan a range of measures to reduce vulnerabilities and the associated level of expected damage and losses caused by these hazards. **Hazards** need not translate into **disasters** if proper planning measures are taken early on to reduce factors that contribute to vulnerability. This workbook provides tools for such planning.

Improving the safety of communities will, at times, involve difficult choices among competing priorities. Maintaining a focus on the long term and allocat-

cities with fewer resources, it is possible to hand-draw maps and transparencies for the layering process. This theme runs throughout the workbook—the LRAP process can be used by any city.

After the city's vulnerabilities have been identified and analyzed, the next phase, outlined in **chapter 5**, is to conduct an inventory of current or envisioned plans addressing those vulnerabilities at the government, private sector, community, and donor levels. The inventory will provide a basis for assessing the gaps between needs and plans.

This gaps and needs assessment provides the foundation for the next phase, described in **chapter 6**, which discusses processes for framing resilience measures (disaster risk mitigation, including climate change adaptation) to deal with vulnerabilities at the city and neighborhood levels that are not addressed in current plans. It also describes methodologies for evaluating trade-offs between identified options and in establishing priorities for action.

Chapter 7 briefly discusses the process of bringing all the pieces together into the LRAP, including the actual steps the city and its partners need to take to make the city more resilient to climate change and natural disasters. The chapter highlights the importance of framing an implementation strategy to ensure that the actions in the LRAP are sequenced and coordinated, financed, monitored, and implemented with the support of partners and stakeholders, and that channels are established to expand, update, and refine LRAP contents.

Chapter 8 concludes the workbook with a discussion of lessons learned from the LRAP process in the pilot cities and considerations for scaling up to other communities.

A series of **appendixes** provide supporting information, and a set of blank **templates** are included as worksheets for other cities embarking on the LRAP process.

The workbook brings to the forefront the interlinkages between planning for growth and urban expansion—including land use and construction codes—in the context of disaster risk reduction and climate change. It is intended primarily for the technical facilitators and other members of the LRAP team who will carry out the day-to-day tasks involved in creating each community's LRAP. The workbook also can be a useful resource for high-level city policy makers (e.g., the mayor's office) and national and provincial government officials. It complements the Safe and Resilient Cities e-Learning course recently launched by the World Bank Institute and similar training initiatives.

ing public expenditures for projects intended to protect the community in the future will require strong political leadership and community awareness. For that reason, one of the main themes of this workbook is that the planning process needs consistent and dedicated support from senior officials at all levels of government. Similarly, the process will be truly effective only if affected interest groups and community organizations understand the need for disaster and climate resilience planning and are invited to participate in the process. Decisions made with broad input from the community will be more popular than those imposed from the top—and probably will be better decisions because they benefit from the local knowledge of those most likely to be affected.

The potential impacts of natural disasters and climate change should be considered in nearly every aspect of urban planning and development. Plans that do not take disaster and climate considerations into account may not be sustainable over the long run; a prime example would be encouraging intensive housing or business development in low-lying coastal areas that likely will be affected by rising sea levels. The LRAP process can support, and should be integrated into, a city's ongoing planning and its vision for the future. At the time the LRAPs were undertaken in Vietnam, for instance, every city was under a national mandate to revise its master plan in the coming year and was thus already thinking about future needs—for better housing and transportation, for example. The LRAPs do not replace such plans but, instead, provide a vehicle for mainstreaming disaster risk mitigation into these plans. As a result, engaging in the LRAP process can help cities comply with existing mandates. Other cities may not be in the process of updating their master plans but may have recently experienced a disaster that may provide the impetus for mainstreaming disaster risk reduction into existing plans. Still others may have motivations such as an upcoming election or exposition, a new study exposing the threats faced by the city, or a new strategy to promote increased investment. Whatever the impetus, developing the LRAP quickly to ride the momentum created will increase its chances of implementation.

Once a city has decided to embark on this process, selection of a dedicated team to oversee and carry out LRAP development is a crucial early step. Most of the detailed work will be done by technical experts, but the LRAP team should include officials with the authority to make decisions and ensure that they are implemented. Also important will be gaining early support from city leaders and stakeholders, including community groups whose interests will be affected by decisions made during the process.

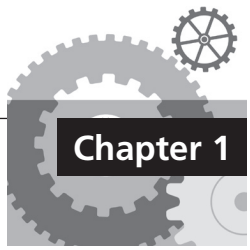
After the city has determined its overall vulnerabilities and made the commitment to developing its LRAP, the next task is to prepare a series of maps that provide a visual representation of the hazards to the city's people, infrastructure, and economy. One set of maps will cover the entire city; others will detail past and future hazards to specific target areas (neighborhoods in flood zones, for example). With these maps in hand, the LRAP team will then evaluate alternatives for measures to reduce the vulnerabilities that have been identified and establish priorities among them.

Many steps in the LRAP process will require choices among competing priorities. Some of these choices will be difficult and sometimes contentious. No city can afford to do everything it wants to do all at once. Priorities must be set, and trade-offs will have to be made. Again, it is important to consult a wide variety of stakeholders to build support for the decisions before they are made. The technical rationale for setting priorities is only one driving factor for decision making; others are political, social, economic, environmental, or financial.

Once the LRAP is complete, an implementation strategy must be defined. The city needs to create a schedule for what actions will be taken, how they need to be sequenced, who will be responsible for their implementation, how they will be resourced, and how their progress will be measured. The city will thus be positioned for substantial but sustainable change. As it gradually increases its resilience, its efforts will leverage on one another, generating positive progress toward safer development.

Abbreviations

CCFSC	Central Committee for Flood and Storm Control (Vietnam)
CCWG	Climate Change Working Group
DEM	digital elevation model
GDP	gross domestic product
GFDRR	Global Facility for Disaster Reduction and Recovery
GHG	greenhouse gas
GIS	geographic information system
IPCC	Intergovernmental Panel on Climate Change
LRAP	local resilience action plan
MARD	Ministry of Agriculture and Rural Development (Vietnam)
MONRE	Ministry of Natural Resources and Environment (Vietnam)
NGO	nongovernmental organization
NTP-RCC	National Target Program to Respond to Climate Change (Vietnam)
SCCC	Steering Committee on Climate Change
SRTM	Shuttle Radar Topography Mission
UN	United Nations



Introduction and Context

Historically, most cities have emerged at locations with good accessibility (e.g., ports or trading routes) or with favorable natural endowments such as an adjacent river, a coastal location, or fertile soils. These geographic settings are often associated with an increased probability of hazard events—floods, cyclones, storm surges, and so on. Low elevation coastal zones, in fact, cover 2 percent of the world's land area but contain 10 percent of global population and 13 percent of the world's urban population (Lall and Deichmann 2009). Many cities also end up being located on or near seismic fault lines as these areas tend to be particularly fertile. It is estimated that 9 percent of the global population lives within 100 kilometers of a historically active volcano, and the highest concentrations of volcanoes are in Southeast Asia (primarily Indonesia and the Philippines) and Central America (Lall and Deichmann 2009).

An area can be hazard-prone without having high exposure per se—for instance, uninhabited areas may be hazard-prone without having much exposure at all. In contrast, exposure in cities tends to be higher than in less inhabited areas due to the concentrations of people, built-up areas, infrastructure, and productive assets. While not all hazards result in disastrous consequences, hazard occurrences may—depending on the magnitude or severity of the hazard as well as the impacts generated (sometimes due to persisting vulnerabilities that have not been addressed)—become **disasters**. Identifying and managing factors exacerbating vulnerabilities at the city level thus becomes crucial.

Climate change is expected to increase the frequency and severity of some hazards, typically hydrometerological hazards including extreme weather, and to introduce new incremental impacts that are less obvious and immediate, such as gradual increases in temperature and gradual changes in rainfall patterns (box 1.1). Cities with high exposure, such as those in low-elevation coastal zones or in hot climates, may be affected by rising sea levels and storm surges, and by longer and more severe heat waves. These direct climate pressures will in turn have a range of short- and long-term consequences—including on human health, physical assets, economic activities, and social systems—depending on how well prepared a city is and how it responds.

In addition to risks that can be managed within the city boundaries, climate change will also affect cities through events that occur outside these boundar-

Box 1.1 Global Climate Change Impacts

- **Sea level rise** is caused by the thermal expansion of seawater, storm surges, and rising and falling of land in coastal regions. Higher temperatures are expected to further raise sea level by expanding ocean water, melting mountain glaciers and small ice caps, and causing portions of Greenland and the Antarctic ice sheets to melt. The Intergovernmental Panel on Climate Change (IPCC) predicts that sea levels will rise by 0.09–0.88 meters by 2100 as compared to 1990.
- **Temperatures** have risen globally by 0.6–2°C in the past century. The highest temperature increases were in 1910–45 and after 1975. The year 2010 was the hottest year on record since 1880, and tied with record global temperatures in 2005 (NOAA 2011). According to projections by the IPCC, the average global air temperature will be 1.4–5.8°C higher by 2100 relative to 1990.
- **Precipitation** has generally increased over land north of 30°N from 1900 to 2005, but has mostly declined over the tropics since the 1970s. Globally, there has been no statistically significant overall trend in precipitation over the past century, although trends have varied widely by region and over time. There has been an increase in the number of heavy precipitation events over many areas during the past century, as well as an increase since the 1970s in the prevalence of droughts—especially in the tropics and subtropics.
- **Extreme events** such as heat waves, heavy rainfall, storms, and coastal flooding are expected to increase in frequency due to large-scale climate change. It is also possible that this large change could initiate nonlinear climate responses leading to even more extreme and rapid (on the time-scale of decades) climate change, including the collapse of the ocean "conveyor belt" circulation, the collapse of major ice sheets, or the release of large amounts of methane in high latitudes leading to further global warming. Although these catastrophic events are much more uncertain than the direct warming due to increased greenhouse gases, their potential impacts are great and therefore should be included in any risk assessment of the impacts of climate change.

Sources: IPCC 2007; NOAA 2011.

ies. Water supply from sources outside of city borders (e.g., snowpacks, reservoirs, and aquifers) may be reduced, with a host of consequences ranging from threatening the drinking water supply to reduced agricultural production that affects food security in cities. Flooding may occur due to siltation or overflow from a dam upstream or from excessive rainfalls in higher-altitude proximate areas, progressively flowing down to the city. Cities may also experience greater in-migration from rural inhabitants pressured by drought or other climate extremes. As of 2010, there were already more than 25 million climate refugees worldwide; this is expected to increase to 50 million by the end of the year (*Climate Refugees* 2010).

Cities can assess, manage, and limit the **risks** of potential disasters and climate change impacts to protect their populations and assets. Managing these risks to build long-term **resilience** involves

- understanding the level of **exposure** and **sensitivity** to a given set of impacts,
- developing policies and effective programs to reduce impacts, and
- identifying resources to promote investments that will limit **vulnerabilities** and enhance **adaptive capacity**.

Adaptation to climate change refers to adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderate harm or exploit beneficial opportunities (IPCC 2007).

Resilience is the capacity of a community or society to adapt and react when exposed to a hazard in order to reach or maintain an acceptable level of functioning. A **resilient** city is one that is able to cope with disaster and climate impacts now and in the future, thereby limiting the magnitude and severity of those impacts. Given the close links between disaster risks and climate risks, efforts to build resilience in cities by integrating climate change adaptation with existing efforts in disaster risk management can be beneficial. However, even if strongly intertwined, adaptation is different from disaster risk reduction. Adaptation to climate change requires cities to plan based on current exposure but also on projected future changes that may unfold through gradual incremental changes (e.g., temperature increases) as well as extreme events (e.g., heat waves). In addition, climate change adaptation can focus on large-scale impacts (e.g., sea level rise) as well as smaller-scale impacts (e.g., localized flooding or drought). By contrast, disaster risk reduction focuses on

events of significant impacts and is generally based on managing current risk based on historical assessments. Moreover, not all disasters are climate related; some may be related to weather and others to seismic risks.

A combined disaster risk management—climate change adaptation approach would thus involve[1]

- understanding existing vulnerabilities to both disasters and climate hazards;
- working with vulnerable groups to understand and prioritize their concerns;
- identifying future potential risks likely to be amplified by climate change as well as new risks that could emerge;
- analyzing less visible climate changes that may not lead to disasters per se but can nonetheless have significant cumulative impacts, such as seasonal shifts and other gradual incremental changes; and
- ensuring that planning and decision making incorporate strategies for dealing with disasters and climate hazards today and in the future.

Cities are growing quickly, especially in East Asia where built-up areas are projected to increase more rapidly than in any other region in the next 20 years. The locations and dense construction patterns of cities often place their populations and assets at greater risk for natural disasters, including those expected to worsen with climate change. Yet cities in developing countries are also confronted with very real development challenges in terms of alleviating poverty and providing access to basic services. Tackling disaster and climate risks should not be seen as a competing agenda but one that should be mainstreamed into existing development goals—recognizing that without such mainstreaming, the achievement of these goals may themselves be threatened. This is also one of the main messages from the *World Development Report on Development and Climate Change*:

> A quarter of the population of developing countries still lives on less than $1.25 a day. One billion people lack clean drinking water; 1.6 billion, electricity; and 3 billion, adequate sanitation. A quarter of all developing-country children are malnourished. Addressing these needs must remain the priorities both of developing countries and of development aid—recognizing that climate change can hamper the achievement of these goals (World Bank 2009b, p. viii).

Still, many local governments are reluctant or unaware of how to mainstream disaster and climate concerns in their political and development agenda, and how to address them in their investment plans and their citywide strategic thinking. And, indeed, there are some measures that have to be taken over and beyond simple mainstreaming. Cities must be proactive in reducing risk and must act quickly because the development trajectory of cities that are expanding will be hard to reverse later. Proactive adaptation—ex ante measures to reduce potential impacts of climate change—is part of broader disaster risk reduction (box 1.2). Developing a local resilience action plan (LRAP), as described in this workbook, is an important proactive adaptation measure in this regard.

Actions in terms of land use, building codes, and investment in large-scale infrastructure must be undertaken with an eye toward the future. This is as true of adaptation as it is of climate mitigation—delays in setting in motion optimal development paths in terms of densities and low-carbon choices will make mitigation exponentially expensive and sometimes altogether inaccessible. Further, the cobenefits of green action often more than cover the costs—reducing pollution has a direct impact on health, quality of living, and attraction of private investment (World Bank 2010a). This is not always the case, however, and cash-strapped city governments in developing countries sometimes do need to choose between adaptation and climate mitigation. Where possible, climate mitigation components can be built into the identified adaptation measures in an LRAP to reduce contributions to global greenhouse gas (GHG) emissions. An explicit low-carbon growth path is not always the primary objective for many developing countries. Vietnam, for instance, has a relatively low share of overall global emissions (figure 1.1), and yet its exposure to hazards is high. Many cities therefore adopt a cobenefits approach to GHG reduction rather than an explicit climate mitigation focus.

Understanding that resilient and/or low-carbon growth is a **choice** that cities face—and that it is within their reach—is the starting point for action. Some cities have been pioneers in taking on this challenge; some have developed LRAPs. Among these latter are Ningbo, China; Yogyakarta, Indonesia; Iloilo, the Philippines; and Can Tho, Dong Hoi, and Hanoi, Vietnam. The objective of this workbook is to draw out lessons from these cities' experiences to formulate a roadmap for other cities to follow. This workbook contains a step-by-step guide to developing an LRAP; since the process was first developed in Vietnam, many of the examples are from this country. It is thus only appropriate that we begin with a close look at Vietnam's hazard profile.

Box 1.2 Adaptation and Mitigation

In the context of climate change, **adaptation** refers to taking steps to deal with climate change as a fact of life—regardless of any attempts that are made to slow climate change in the first place (climate **mitigation**).

Reactive adaptation refers to responding to climate impacts after they occur. Reactive adaptation is part of overall disaster risk response and recovery, as shown below.

Proactive adaptation refers to structural and nonstructural measures to reduce potential impacts of climate change *before* they occur. Examples of structural measures include building stronger sea walls in low-lying areas, installing tsunami warning systems, and moving electrical lines or other vital public services away from areas prone to damage. Examples of nonstructural measures include strengthening and enforcing guidelines on land development and new settlements, capacity building for key government agencies, establishing evacuation routes and practicing drills, and conducting studies to better anticipate and plan for climate impacts. At the provincial and city levels, developing a local resilience action plan—as described in this workbook—is an important nonstructural proactive adaptation measure. Proactive adaptation is part of **disaster risk reduction and mitigation** (which also covers risks related to nonclimatic hazards such as seismic risks).

While disaster risk mitigation refers to actions that reduce the severity of future disasters, **climate change mitigation** refers to slowing the process of climate change by lowering the levels of greenhouse gases (such as carbon dioxide) in the atmosphere. These gases, emitted by the burning of fossil fuels in addition to natural processes, trap heat in the upper atmosphere—heat that is returned to the Earth's surface in the so-called greenhouse effect.

Examples of climate mitigation include reducing the amount of energy spent on lighting and temperature control of buildings, improving the fuel efficiency of automobiles, and reducing the greenhouse gas emissions of electrical power generating plants.

For many developing countries, the current priority is adaptation to the effects of climate change rather than climate mitigation to reduce the country's contributions to climate change. Still, opportunities for climate mitigation in the context of adaptation can be considered. For instance, when building a raised walkway or a bridge to appropriate standards, reflective pavements can reduce the amount of heat absorbed. Energy-efficient street lighting can be considered when new roads are built to divert traffic away from flood-prone areas. Such measures are often no cost or low cost. They can actually be cheaper than the alternatives in terms of operation and maintenance over the life of the investment, even if the initial fixed cost is marginally greater (e.g., energy-saving light bulbs). Dual-response measures, such as urban forestry or gardens on top of buildings ("green roofs") serve both a climate adaptation purpose (absorbing water runoff) and a climate mitigation purpose (absorbing carbon dioxide) without any changes in design.

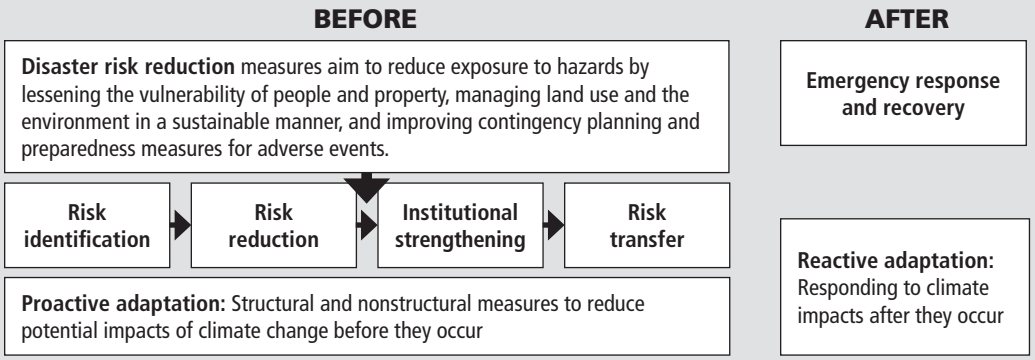
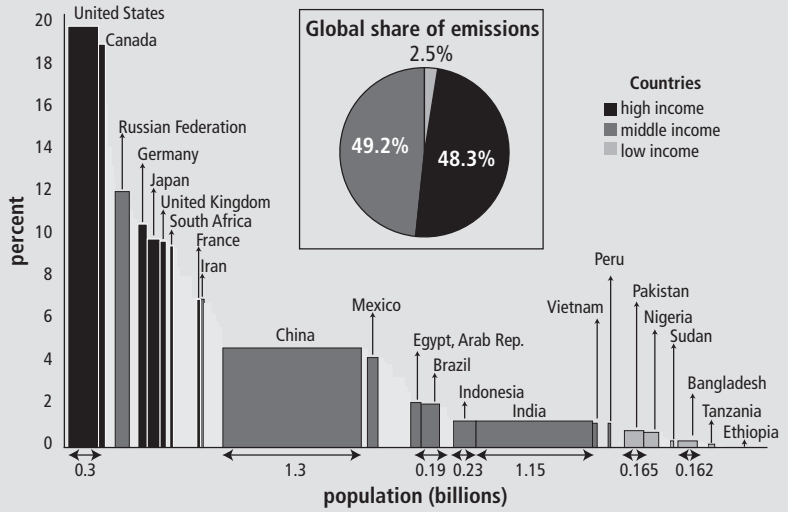


Figure 1.1 Vietnam's GHG Emissions Compared to Those of Other Countries



Sources: EIA 2006; World Bank 2008.

1.1 Vietnam's Hazard Profile

Vietnam has a population of nearly 90 million, which makes it the third largest country in Southeast Asia and the 13th largest (by population) in the world. A little less than 30 percent of the population lives in urban areas, but the urban population is growing rapidly at a rate of 3.4 percent per year. Many of the country's cities are located along Vietnam's long coastline, rivers, and low-lying areas, rendering them particularly susceptible to hydrometeorological disasters now and into the future. Because of its topography, Vietnam is susceptible to several types of natural disasters (table 1.1). Disaster risk reduction and climate adaptation clearly must be mainstreamed into Vietnam's urban strategy.

From 1990 to 2009, Vietnam suffered an average annual loss of 457 people and an estimated annual economic loss equivalent to 1.3 percent of gross domestic product (GDP) as measured by purchasing power parity, or $3.6 billion in 2010 GDP, due to natural disasters (UNDP 2011). Over the last decade, there has also been a clear rising trend in annual economic losses (UNDP

Table 1.1 Vietnam's Relative Disaster Frequency

High	Medium	Low
Flood	Hail rain/tornado	Earthquake
Typhoon	Drought	Frost
Inundation	Landslide	Damaging cold
	Flash flood	Deforestation
	Fire	

Source: GFDRR 2011, p. 199.

2011). Floods, typhoons, and inundation are the most frequent disasters, with floods and storms responsible for 91 percent of affected persons and ranking highest in terms of economic damage. Because of the high concentration of population along the coastline and in low-lying deltas, particularly of the Mekong and Red Rivers, such hazards can cause loss of life and heavy damage to assets, infrastructure, and economic activity (GFDRR 2011).

Vietnam experiences an average of six to eight typhoons or tropical storms of varying intensity each year, with the northern and central coastal regions being hardest hit in the early months of the storm season. Communities along the coast are directly affected, as are communities in upland areas which can experience flash floods resulting from the heavy rains of typhoons. River plain flooding is extensive and prolonged throughout the wet season in the large deltas. Because most of Vietnam's 2,360 rivers are short and steep, heavy rainfall in their basins produces intense even if short duration floods.

After typhoons and floods, drought is responsible for the greatest amount of damage to livelihoods and the economy. Drought is an annual phenomenon in Vietnam, usually occurring from December to April.[2] In recent years, drought periods have started earlier and are lasting longer. In 2010, an unprecedented drought affected the majority of provinces in the country, resulting in severe pressure on agricultural output and the provision of electricity.

Climate change is likely to increase the frequency and intensity of the hydrometeorological disasters that Vietnam faces. In 2007, an assessment by the World Bank listed Vietnam as one of the five countries in the world potentially most affected by climate change.[3] According to one estimate, a 1 meter rise in sea level would affect 39 of the 64 provinces in six of Vietnam's eight

economic regions. About 20 percent of the communes could be wholly or partially inundated, with the Mekong River Delta being the most seriously affected area. Also according to this estimate, a 1 meter rise in sea level would affect approximately 5 percent of Vietnam's land area, 11 percent of the population, 10 percent of total GDP, and 7 percent of agricultural inputs (Dasgupta et al. 2007).

Many of Vietnam's cities will be increasingly affected by natural disasters. This will pose a danger to the country not only because of the large concentrations of people in those urban areas but also because cities are a critical element of Vietnam's economic growth and poverty reduction strategy. Even at today's relatively low level of urbanization (30 percent, according to the 2009 census), the country's cities are the major contributors to its GDP (70 percent, according to a 2006 World Bank study).[4] According to the United Nations Human Settlements Programme (UN–HABITAT), 77 percent of the population growth in the 2000–09 decade occurred in cities, and approximately 1 million people are added to the urban areas every year. Forecasts are that Vietnam's urban population will exceed the rural population by 2040.

1.2 National Policy and Institutional Environment

Vietnam has a long history of preparedness for, and active response to, natural disasters. The extensive system of dikes and sea walls is evidence that citizens and leaders over the centuries have recognized the country's vulnerability to the consequences of typhoons and other tropical storms.

1.2.1 National Policy Framework

The National Strategy for Natural Disaster Prevention, Response, and Mitigation to 2020 and the National Target Program to Respond to Climate Change (NTP-RCC) contain Vietnam's overarching policies and programs on disaster risk management in the context of climate change and specific climate change measures. These are complemented by other dedicated ordinances and laws. The National Assembly has adopted numerous pieces of legislation related to natural disasters, notably the Law on Water Resources (1998), the Ordinance on Flood and Storm Control (1993), the Law on Dikes (2006), and the Environment Protection Law (1998).

Even so, according to an analysis by the Global Facility for Disaster Reduction and Recovery,

much of the legislation lacks clear institutional arrangements for enforcement and the current organizational structures, mandates, annual budget earmarks and working agenda focus largely on disaster response rather than prevention. There is no professional and specialized cadre of staff who focus on disaster management. Instead, it is managed in an "as-needed" basis, part-time, by staff of the agriculture and rural development sector, mainly under the irrigation and dyke management sub-sectors (GFDRR 2009, p. 110).

1.2.2 National Institutional Framework

The Ministry of Natural Resources and Environment (MONRE) has been designated the lead agency for climate change coordination in Vietnam, while the Ministry of Agriculture and Rural Development (MARD) maintains overall responsibility for natural disaster mitigation and response. In addition, the Ministry of Construction has responsibility for the country's drainage systems and major public works, the Ministry of Planning and Investment is responsible for land use and master planning, and the Ministry of Science and Technology is involved in climate forecasts.

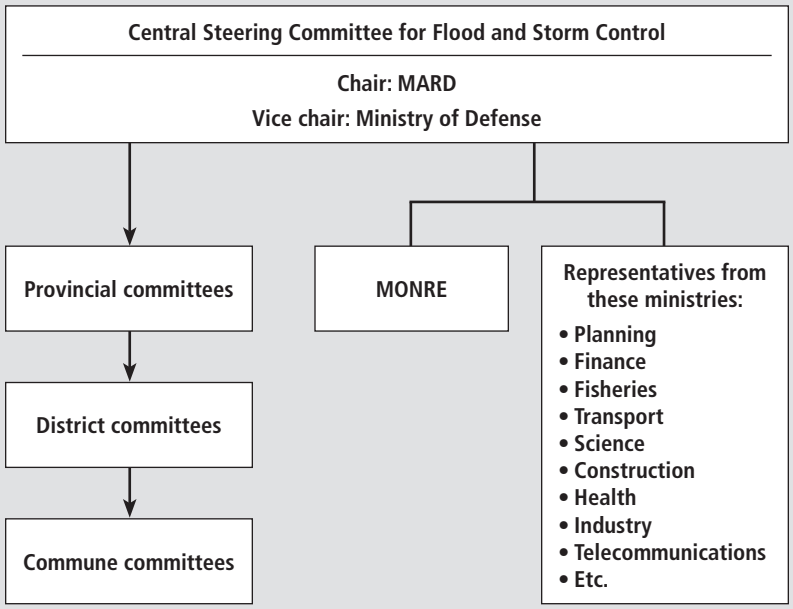
The Central Committee for Flood and Storm Control (CCFSC), chaired by the minister of MARD, coordinates disaster risk management activities in Vietnam. Committee members include representatives from MONRE and the Ministries of Planning and Investment, Finance, Fisheries, Transportation, Science and Technology, Construction, Health, Industry, Labor and Social Affairs, Telecommunications, and Foreign Affairs; the Vietnam Red Cross, Vietnam TV, Voice of Vietnam, the Department of Dikes Management and Flood Control, and the National Hydrology and Meteorology Center are also represented (figure 1.2).

MARD on Disaster Risk Management

MARD is coordinating the National Strategy for Natural Disaster Prevention, Response, and Mitigation to 2020 which was approved by the government in November 2007. The latter followed the Strategy and Action Plan for flood mitigation which had been adopted in 1994.[5] After the approval of the National Strategy, provinces and cities have to make their own local strategic action plans based on main directories defined by the CCFSC.

The National Strategy focuses on floods, storms, and drought. In addition to setting policy for disaster response, it provides long-term strategic orientations. The strategy includes consolidation of organizational structures, community awareness raising, forestation and protection of upstream forests,

Figure 1.2 Horizontal and Vertical Coordination



Source: Adapted from GFDRR 2009.

investments in science and technology for disaster risk management, structural measures, and programs on strengthening warning systems and upgrading forecast capacities. All 64 provinces and cities in Vietnam are tasked with developing action plans to implement the National Strategy.

MARD and the CCFSC preside over implementation of the National Strategy. Specific implementation responsibilities have been assigned to ministries, sectors, and local entities. The Ministry of Planning and Investment takes the lead and works in collaboration with the Ministry of Finance, MARD, the CCFSC, the National Committee for Search and Rescue, and other relevant ministries and sectors to provide annual investment resources in accordance with the laws to effectively implement the Strategy. MARD is in charge of inspection and assessment of implementation by ministries, sectors, and local entities.

MONRE on Climate Change

The NTP-RCC, which was approved by Decision 158 in December 2008, defines a set of actions at the central, provincial, district, and commune levels in three phases: Phase 1 (2009–10), start-up; Phase 2 (2011–15), implementation; and Phase 3 (after 2015), development. The targets under Phase 1 are complete climate change scenarios, focusing in particular on sea level rise; understanding the current situation and trends of climate change parameters; and implementing pilot projects to assess climate change impacts. The NTP-RCC provides a framework for ministries, sectors, and provinces to develop their own action plans, primarily in response to rising sea levels.

At the sector and provincial levels, climate change responses are still in process of being addressed systematically. MARD has developed an action plan for adaptation and mitigation to climate change, with specific initiatives beyond ongoing disaster risk reduction measures, reflecting the strong connections and linkages between disaster risk management and climate change adaptation and the difficulty of treating them separately (box 1.3).

Ministry of Construction on Spatial Planning

The Ministry of Construction is a key player in urban planning in terms of providing guidelines and regulations related to building codes and master planning. A sustainable urban development component, sponsored by the Danish Cooperation and Aid Agency (DANIDA), has assisted the Ministry of Construction in the preparation of a handbook on urban planning and design with reference to climate change mitigation and adaptation considerations.

In Vietnam, the Ministry of Planning and Investment is responsible for the socioeconomic development plan, the Ministry of Construction is responsible for spatial plans (also called construction or master plans), and line ministries are responsible for sector development plans. In theory, spatial plans are supposed to follow socioeconomic plans and sector plans; however, in practice the plans do not always converge.

Spatial plans are prepared at four levels of detail: orientation plans (national policy), regional plans (introduced in 2005), master plans (at the province or city level), and detailed area plans (ward, industrial zone, or project level). Master plans are required to include long- and medium-term direction for physical development, the form of the urban space, and infrastructure networks and facilities. They also cover the characteristics of urban areas, population size, land use, resettlement, redevelopment, conservation, and zoning.

Box 1.3 Action Plan for Adaptation and Mitigation of Climate Change for the Agriculture and Rural Development Sector, 2008–20

The Action Plan Framework for Adaptation and Mitigation of Climate Change for the Agriculture and Rural Development Sector for 2008–20 was endorsed by the Ministry with Decision 2730 dated September 30, 2008. Its main objective is to enhance capability of mitigation and adaptation to climate change to minimize its adverse impacts and ensure sustainable development of the agriculture and rural development sector in the context of climate change. It focuses on

- ensuring the stability and safety of residents in cities, different zones and regions, especially the deltas of the Cuu Long and Red Rivers, and the central and mountainous areas;
- ensuring stable agricultural production and food security for an area of 3.8 million hectares with two seasonal rice crops; and
- ensuring the safety of dike and infrastructure systems to meet requirements for disaster prevention and mitigation.

The plan's main tasks are awareness raising on climate change impacts and adaptation activities in the agriculture and rural sector, building a scientific foundation, enhancing research and studies in the field, developing training, promoting international cooperation, and developing a policy system to integrate climate change in sectoral development programs. Some priority activities are identified here, such as capacity strengthening of dedicated departments within the ministry (e.g., the steering committee for climate change adaptation and mitigation), development of national standards and national technical procedures in planning and designing in the context of climate change, and carrying out scientific research programs for agricultural and rural infrastructure. All the activities are meant to be coordinated by MARD but need mobilization from all other relevant ministries, sectors, research institutes, and local authorities. Local authorities are identified as one of the agencies to formulate and implement mitigation and adaptation projects to climate change. The action plan lists a set of measures, without providing implementation details.

In 2009, the Adjustment of the Orientation Master Plan for Urban Development to 2025 and Vision to 2050 were approved. In this new framework, a step-by-step approach to urban planning is advocated. In the first phase until 2015, to guarantee economic growth, the priority is to develop key economic zones in large urban areas, with Hanoi, Danang, and Ho Chi Minh City as the urban hubs in the three Northern, Central, and Southern growth poles. Two other phases, for 2016–25 and 2026–50, follow.

Another significant reform was introduced through the new Law of Urban Planning (June 2009), which focuses on the preparation, appraisal, approval, and adjustment of urban planning. Under this law, the Ministry of Construction, in coordination with relevant parties, is responsible for ensuring that disaster risk reduction and climate adaptation are mainstreamed into urban plans, as an essential step toward enhancing Vietnam's resilience.

Ministry of Planning and Investment: Funding Implementation

The Ministry of Planning and Investment is an agency of the government that manages financial planning and investment, including the provision of general advice on strategies; national socioeconomic development planning; policies for general economic management and for some specific areas such as domestic and foreign investment, industrial parks, and export processing zones; official development assistance sources; and business registration. The ministry is also responsible for the development of the five-year socioeconomic plan that leads the development and growth of the country. Environmental protection is one of four pillars of the 2006–10 plan and of the 2011–15 plan.

1.3 Opportunities for Coordination

The government has an opportunity for institutional coordination across ministries at the national level. In October 2009, MARD and MONRE jointly held the first National Forum on Disaster Risk Reduction and Climate Change Adaptation. The high-level forum provided a unique opportunity for ministries, departments, provinces, scientific institutions, diplomatic bodies, donors, and nongovernmental organizations (NGOs) to share ideas. As stated by Prime Minister Mr. Hoang Trung Hai, "This national forum will be a good starting point to promote the establishment of a recurring platform for information sharing and institutional development, and will contribute to the effective implementation of natural disaster prevention, response and mitigation" (CCFSC 2009).

With policy frameworks already in place and institutional coordination moving in the right direction, targeted tools—such as this workbook—to advance implementation at the local level will be well positioned at this point in time. Equally important will be the action experiences from the pilot cities—Can Tho, Dong Hoi, and Hanoi—that implemented the methodology in this workbook (appendix A).

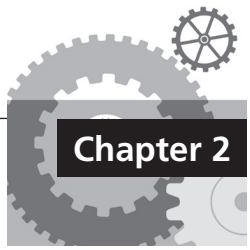
Recognizing that proactive planning is necessary, all three of these cities made commitments under the World Bank Climate Resilient Cities program in Vietnam to develop an LRAP, through the formation of a steering committee (policy level) and working group (technical level) at the city level. The World Bank team provided technical assistance to facilitate the process, but the LRAP is a locally owned product. It is the beginning, rather than the end, of a process toward becoming disaster and climate resilient. The LRAP repre-

sents a commitment to a set of priority actions that each city will now need to undertake and monitor the progress of.

From the experience of the three pilot cities in Vietnam as well as those that replicated the experience in China, Indonesia, and the Philippines, it can be seen that the LRAP process is relevant for a wide variety of cities. What is needed is the commitment to become climate resilient, the initiative to undertake the LRAP planning effort, and a dedicated team for planning and implementing actions. Each city will approach the planning process in its own way, depending on its own unique circumstances and needs.

Notes

1. Adapted from World Bank (2011a).
2. A nationwide drought in 1998 affected about 3.1 million people, particularly in the central and southern provinces and in the Central Highlands, causing estimated damage of approximately D 500 billion ($37 million). Other droughts in 2002 and 2005 caused estimated damage of D 2,060 billion ($135 million) and D 1,743 billion ($110 million), respectively.
3. Vietnam's April 2009 Population and Housing Census found that the Red River Delta in the north and the Mekong Delta in the south are home to 43 percent of the country's population (General Statistics Office 2009; www.gso.gov.vn).
4. World Bank (2006). According to the April 2009 census, about 30 percent of Vietnam's population lives in urban areas, compared to 23.5 percent in 1999.
5. Intense discussions have been under way on a Strategic National Action Plan on Disaster Risk Reduction, but one has not yet been drafted.



Demystifying the Local Resilience Action Plan

A local resilience action plan is a planning document to help a city government improve its resilience to the potential effects of climate change and natural disasters as part of its broader future growth and development objectives. It reflects analysis of risks facing the city and various options to mitigate these risks, and results in a strategic set of short- (less than one year), medium- (one to three years), and long-term (more than three years) structural and nonstructural measures designed to increase the city's resilience. For some cities, having a stand-alone LRAP can be an important way of articulating the overall goals in reducing vulnerabilities and in tracking progress. For other cities, having a separate plan will detract from the ability to mainstream it into ongoing urban master plan updates or sectoral strategies; in these instances, it is more important to have pieces of the analysis that can be fed into other ongoing planning documents. Indeed, while some cities have preferred to have a stand-alone LRAP (e.g., Can Tho), others have chosen to produce outputs that can feed into other planning documents (e.g., Iloilo).

While the LRAP outlines a set of discrete activities, the **process** of formulating the action plan involves sensitization to the need for mainstreaming disaster risk reduction into broader city planning and management operations on a day-to-day basis. A resilient city is one whose government and people understand the hazards faced, manage growth while systematically

addressing disaster risks, and adapt to the local impacts of climate change. The LRAP also provides space for recognizing the cobenefits approach—in other words, are there developmental priorities that also reduce risk, or vice versa? These activities will likely receive more support for implementation. Similarly, the LRAP also allows cities to identify dual-purpose activities that reduce disaster risk and mitigate against future climate change—for example, rooftop gardens that absorb carbon but also absorb excess rainfall. Some cities, such as Yogyakarta, have adopted more of a "green" focus in their LRAPs than have others.

An LRAP makes the case that building resilience is proactive, not reactive, and therefore is a critical element to be integrated into master planning and urban development strategies. It is important to remember that an LRAP, like any urban plan, is not a static document. Rather, it is part of a series of activities that, over time, reduces a city's vulnerabilities to natural disasters and thereby makes its citizens, businesses, and infrastructure safer. As experiences with implementation take root, results should be evaluated and fed back into an updated LRAP.

While the following provides standard guidelines for developing an LRAP, this process can be customized for different city contexts and priorities. Some cities may have better historical hazard data and downscaled climate projections than others; similarly, some may have better capacity for modeling future risk. The LRAP enables a city to start at any point and build from there. There are also differences in approaches. In some cities, like Hanoi, a top-down approach is encouraged with respect to planning; in others, such as Yogyakarta, the process is inherently community-driven. Even though cities may have different starting points, use different processes for developing LRAPs, identify different priorities, and mainstream the necessary actions in different ways, the end goal remains the same: to build more resilient cities.

2.1 Steps in Local Resilience Action Planning

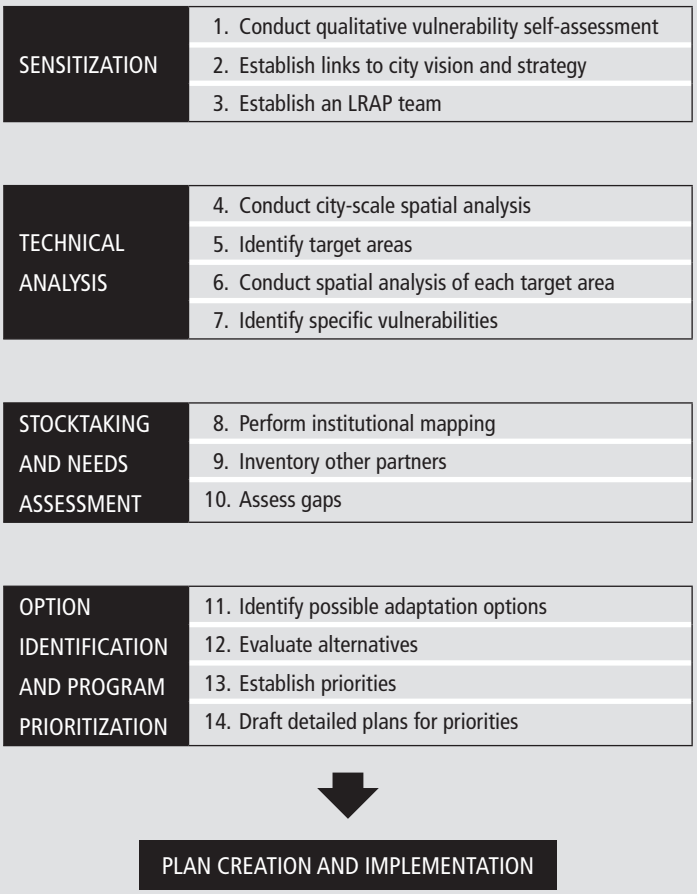
A city develops its LRAP by taking several steps, each of which requires the involvement of multiple sectors of the community. Broadly, the steps can be grouped into the following categories or phases of action:

- Sensitization
- Technical analysis

- Stocktaking and needs assessment
- Option identification and program prioritization
- Plan creation.

This last then feeds into implementation and evaluation—and feedback to the dynamic regeneration of the LRAP. Figure 2.1 provides an overview of the process and steps, which are described below.

Figure 2.1 The LRAP Process



Source: Authors.

2.1.1 Sensitization

The starting point for the LRAP process is understanding the needs and viewpoints of different groups with vested interests in how the city improves its resilience. This includes government officials from ministries such as environment, agriculture, construction, and planning. It is also important to consult with those who may not think of themselves as having an interest or involvement in the question of planning for climate change and natural disasters. Examples could be officials in a sector such as education, health, or transportation who might believe that climate change does not directly affect what they do. Because all sectors of a city ultimately *are* affected by climate change and natural disasters, it is important that their awareness be raised and that they be involved in the vulnerability assessment and planning process.

STEP 1. Conduct Qualitative Vulnerability Self-Assessment

As a first step to sensitization of the importance of, and links between, disaster risk management, climate change adaptation, and city management functions, representatives of the various local government departments should come together at a roundtable meeting. At this session, a consolidated qualitative vulnerability self-assessment that looks at city-level characteristics should be completed. Among the characteristics to consider are geography, population, administrative structure, public revenue base, institutional capacity on disaster risk management and climate change adaptation, built environment, economic base, and exposure to natural hazards and climate change.

At this stage of the process, the roundtable should discuss and be aware of **hotspots**—the areas of a city that are particularly vulnerable to natural disasters. Examples might include high-density neighborhoods, industrial zones, or vital roadways located in the floodplain of a major river subject to frequent flooding. The term "hotspot" does not apply just to geographic areas. It also can refer to particular communities or groups of people, such as the poor or elderly; entire sectors of the economy, such as fisheries or tourism; or infrastructure networks, such as drainage systems. Participants may also decide that the entire city is a hotspot—this may be the case because of the lack of a comprehensive disaster response system or dated urban planning documents.

Even for advanced cities, going through this process sometimes uncovers interlinkages between issues that may otherwise have been overlooked. Thus, even when cities are considered to be well versed in the basic qualitative vulnerability assessment process, this quick exercise can be well worthwhile.

STEP 2. Establish Links to City Vision and Strategy

The LRAP process should complement the city's vision and goals for the future. For example, if the city has a goal of reducing poverty by 5 percent, ensuring economic growth by over 10 percent per year, or increasing industrial production by 25 percent by a certain date, that goal should be incorporated into the LRAP. If the city's poor live in neighborhoods prone to flooding, how can the city plan to make these neighborhoods safer or move the people to other, safer neighborhoods while providing better jobs and services that will lift these people out of poverty? If the city wants to attract industry, how can it make sure that new factories, and their supply chains, will not be damaged by floods or storms? Disaster risk management is not a parallel activity to, but rather an integral part of, the city's development vision, and requires adequate attention and mainstreaming as part of the strategy to attaining that vision.[1] Recognizing these connections is part of the overall sensitization process. If a city does not have a vision, this could be a good impetus to create one.

STEP 3. Establish an LRAP Team

City government representatives (preferably at a roundtable) will need to determine how best to develop the LRAP. One way is by establishing a team to be responsible for guiding plan development. This LRAP team should consist of officials at the policy level who can undertake key decisions necessary for implementation, as well as technical personnel who can undertake the analysis required for the LRAP.

The entire process of developing an LRAP presents both a leadership challenge and an opportunity for a city government. Success depends on a participatory and credible local governance structure. The LRAP team need not displace existing institutions or create parallel bodies with overlapping mandates; where a relevant body exists, its mandate can be broadened to include LRAP development. However, where no such body exists, city steering committees established to address climate change as an ongoing responsibility should be considered to be a permanent local government function.

An important corollary to establishment of the LRAP team is an affirmation, at the outset, of a commitment to implement the actions emerging from the LRAP process. A high-level endorsement of the final LRAP should be planned for; this will make the end goal more viable and the LRAP process more meaningful. City representatives can discuss whether this commitment

needs to be documented in some way and whether there are options available to make it binding.

Partnerships with centers of local expertise, especially universities and technical institutes, are essential for creating and integrating projections of future impacts of climate change and natural disasters into the planning process. These partnerships also provide long-term stability to the LRAP process and can help determine the city's long-term climate-resilience priorities which span across the terms of officials and governments.

2.1.2 Technical Analysis

Once the city has involved important sectors of the community, reviewed its long-term vision, and identified its hotspots in broad terms, the next task is to identify the city's specific vulnerabilities through rigorous technical analysis.

STEP 4. Conduct City-Scale Spatial Analysis

The easiest way to visualize a city's vulnerabilities is by looking at "macromaps" that place those vulnerabilities in the context of the city as a whole both now and as projected in the future. These macromaps are created by overlaying a series of mapping layers showing the city's administrative boundaries, physical characteristics, and infrastructure (baseline map); its socioeconomic features, including pockets of poverty and vital commercial and industrial areas; and its hazard profile, showing areas and neighborhoods prone to natural disasters and the effects of climate change. Both a current status macromap and a future growth macromap are generated in this step, using either a computer software program or with transparencies or tracing paper. These maps should be as complete and detailed as possible, both in describing the current situation and in projecting future growth, development, and changes. This will allow for assessment of whether, for example, existing vulnerabilities will be magnified or new risks introduced to areas not previously affected by disasters.

STEP 5. Identify Target Areas

The relative importance of the data contained in each macromap layer will vary according to the city's vision and priorities. The LRAP team next determines this importance and identifies the **target areas** on which to focus. On each layer of the macromaps, the LRAP team will circle the most vulnerable and most critical areas, such as poor neighborhoods or sections of roadways,

based on the information presented in each layer. The respective layers of the two macromaps—current and future—are then placed on top of one another to give a composite picture of the vulnerability of the actual and future growth areas in the city. For instance, an area that is subject to repeated flooding might be a relatively low priority because it is uninhabited or primarily agricultural where annual floods are an asset. Another area might be slightly less vulnerable to natural disasters but is a higher priority because it is densely populated or has high economic significance. This will be the graphic guide for the local resilience planning process. Planners look for the confluence of areas that are circled as the most vulnerable in each layer. These are the target areas on which to focus priority attention. A city can start with just a few target areas and build up to the entire city, depending on the time and resources it has available for this exercise, as well as the degree of current and expected future hazards identified in the macromaps.

STEP 6. Conduct Spatial Analysis of Each Target Area

This process of creating layered maps for the city as a whole should be repeated at a higher resolution (for ward-level analysis) for each target area of the city that has been identified. These more detailed maps will show streets, bridges, major buildings, schools, electrical power lines, and other significant features, as well as hazards and socioeconomic characteristics and activities.

STEP 7. Identify Specific Vulnerabilities

With these local-level macromaps, planners can identify vulnerable areas such as a ward or community where the combination of layers indicates high adverse impact of natural hazards or climate change impacts, or even specific vulnerabilities—for example, an important institutional building or a vital transportation link that is exposed to flooding or likely to be severely affected by climate change.

This process of identification allows planners to develop a **target list of vulnerabilities**: the areas of the city and the population and infrastructure within those areas that are most vulnerable to the effects of natural disasters and climate change.

2.1.3 Stocktaking and Needs Assessment

Once the city's risk areas have been identified and prioritized, the LRAP team next turns its attention to the main issues a city faces in reducing vulnerabili-

ties to natural disasters. Perhaps the city's administrative structure is too cumbersome to respond adequately to crisis situations. Or maybe its building codes are not sufficiently strong in requiring that houses and other buildings meet certain standards. Through a series of three steps, the LRAP team conducts a systematic needs assessment of city resources in addressing vulnerabilities.

STEP 8. Perform Institutional Mapping

The first step in conducting the needs assessment is to identify the government institution(s) responsible for addressing each item on the target list of vulnerabilities. A vulnerable road would be the responsibility of the highway department, for example; the drainage system might be under the purview of the department on flood and storm control. For some assets, multiple agencies may be responsible.

The LRAP team should also at this time inventory the projects, policies, and plans of these various responsible institutions that have a bearing on disaster risk reduction but do not specifically correlate to the list of vulnerabilities identified. This involves the creation of an inventory of relevant documents from the individual institutions, as well as of citywide master plans, capital budgets, and proposals for future growth. This exercise enables planners to identify already existing plans that might address items on the target list of vulnerabilities. For example, an endangered roadway could be found to be already scheduled to be elevated and rebuilt. Equally important, planners will be able to identify duplicative projects across different departments. These present opportunities for diverting resources from duplicative or unnecessary projects toward needs that are currently unfunded.

STEP 9. Inventory Other Partners

The next step is to identify other active organizations involved in reducing risk in the city. These partners could include donors, NGOs or community groups, schools, and even individual households or neighborhood associations. It is important to map out the geographical areas in which these groups are involved, so duplication and overlap can be identified and activities refocused to address unattended-to priorities.

STEP 10. Assess Gaps

The remaining vulnerabilities—those the city has no current plans to address—are then subjected to a **gaps assessment**. The gaps assessment comprises technical, institutional, and financial capacity assessment and becomes the

starting point for the next set of steps, which aim to identify and prioritize resilience measures to be undertaken.

2.1.4 Option Identification and Program Prioritization

The last four steps in the LRAP process focus on matching resilience measures to identified vulnerabilities. These measures can be either structural (replacing a building or a bridge) or nonstructural (policy reforms, new zoning laws, raising awareness in the community). The LRAP team identifies, evaluates, and prioritizes options.

STEP 11. Identify Possible Adaptation Options

The LRAP team next develops a list of adaptation options for each remaining item on the target vulnerabilities list. For example, what are the options for reducing the vulnerability of a high-density neighborhood located in a flood zone? One option would be to relocate the entire neighborhood. An alternative might be to build new or stronger dikes to reduce the flood hazard. Nonstructural measures might include an awareness-raising campaign to alert residents to the dangers of flooding, coupled with improved plans to evacuate the neighborhood when flood waters reach a certain level. Stakeholder consultation may be a valuable source of information that city planners had not previously considered. Indeed, some of the measures may already be taking place at the private/community level (identified in Step 9), in which case the government agenda is reduced.

STEP 12. Evaluate Alternatives

Where several alternative options exist to tackle a single vulnerability, an economic assessment of the impacts of each (costs and benefits) could be developed to provide a better understanding of their relative merits and inform decision makers as to which is more likely to increase social welfare most. Other factors and criteria, including financial feasibility and political and technical complexities, as well as distributional (equity) issues should also be considered in assessing alternatives. The outcome of this step should be a ranking of alternatives from most to least preferred.

STEP 13. Establish Priorities

Establishing priorities involves making trade-offs. The LRAP team will need to identify the critical actions that can be undertaken with funds available at

the city level on the basis of the alternatives evaluation. Additional resources may be needed for other measures, and a strategy for raising finances should also be considered. If the city is not able to undertake all the adaptation measures identified, it can select among them by looking at benefit-cost ratios (based on the analysis in Step 12), least-cost parameters, maximum benefit, or avoided damages considerations. Once again, other considerations could include technical complexity, political feasibility, time frame, and so on.

STEP 14. Draft Detailed Plans for Priorities

Once the prioritized set of measures has been identified, details for each in terms of objectives, cost parameters, and implementing responsibilities should be included into project proposals.

2.1.5 Plan Creation and Implementation

Once the 14 LRAP steps have been completed, the information needs to be pulled together into the actual LRAP document. The plan will list the actions to be taken, ranked by priority; it will also provide the estimated costs, the designated agency or department responsible for each action, and projected completion dates. The basis for these actions will be detailed and explained based on LRAP risk assessment and analysis.

Next, an implementation strategy must be developed. It should address issues such as institutional coordination, sequencing of actions, budget, communication, and monitoring and evaluation. The LRAP implementation plan needs to be complemented with a fund-raising and budget-monitoring strategy as well as a communication plan. To assess whether the LRAP is on track, an ex ante set of performance indicators will need to be agreed on for monitoring progress and evaluating results.

The LRAP process is based on self-assessments and available information. It is important to recognize that the LRAP document is designed to be improved over time through additional information, lessons learned, and experience gained. In other words, the creation of the LRAP is not an end in itself; rather, it is the beginning of the process for making a city climate resilient well into the future. (In this regard, see box 2.1.)

Box 2.1 A Complement to the LRAP: The Multi-Hazard City Risk Index

The Multi-Hazard City Risk Index is a model tool being developed by the World Bank and piloted in Bangkok, the Manila metropolitan area, and Ningbo, China, with the objective of quantifying and aggregating risk at a 500-by-500-meter cell level across the entire city. The methodology starts with mapping a range of metropolitan elements—including people (identifying, where possible, vulnerable groups such as women, the very young, the elderly, students, workers, and the poor), residential buildings (disaggregating, where possible, in terms of levels of density as well as informal areas/slums), employment buildings (disaggregating by commercial and industrial uses), social service facilities (e.g., schools and hospitals), and infrastructure assets (e.g., energy, flood control, water supply, wastewater, solid waste, and transport infrastructure), and environmentally sensitive areas. This complements the mapping exercise in the LRAP's Step 4.

Next, indexes for up to 13 different types of hazards—earthquakes, tsunamis, volcanic eruptions, typhoons, severe thunderstorms, monsoons, landslides, tornados, wildfires, drought, extreme temperatures, storm surge, and sudden subsidence—are established and exposure indexes calculated. This task could complement and supplement the hazard mapping performed in the LRAP's Step 4.

The greatest value of the Multi-Hazard City Risk Index is in identifying and scoring a range of vulnerabilities to each specific hazard in terms of people, buildings, infrastructure, and environmentally sensitive areas. Its 28 vulnerability parameters cover three broad areas—physical susceptibility, socioeconomic fragility, and regulatory and institutional frameworks. The model allows the user to see what would happen to total risk calculations (or risk in a certain part of the city) if particular vulnerability scores were to change. For instance, in a city with no or poor early warning systems, how would overall risk scores be affected if such systems were to be established or improved upon? Such an exercise can help cities identify which measures they can take to reduce overall risk. In the context of the LRAP, this information feeds into Steps 4–10 and, to some extent, in establishing priorities (Step 13).

The model is built to calculate current (2010) and future (2030) risk for an entire metropolitan area but can be disaggregated for specific locations, types of assets, or hazards. The Multi-Hazard City Risk Index is still in the process of being refined, but it offers some ideas to cities undertaking the LRAP in terms of what to measure and how this can be a tool in identifying vulnerabilities that need to be addressed and, on some level, track progress in reducing these vulnerabilities.

Source: World Bank 2011b.

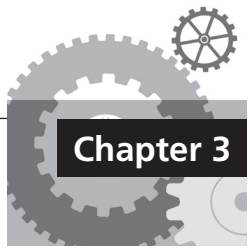
2.2 Results Matter

Implementation of activities, monitoring of results, and mechanisms for feeding these results back into an updated LRAP will be the real test of the plan's success. The success of the LRAP is measured through results and the changes identified and implemented. Equally important is how the issues of resilience and disaster preparedness, mitigation, and adaptation have been embraced by and included into the planning and governance of the city. The local governance structure will reflect its commitment to creating and maintaining a resilient community. The technical, financial, and institutional

support required for this process represents an ongoing commitment of the city to sound urban management. That commitment is reflected in the city's budget for project development, capital investments, and capacity building to access local expertise, domestic capital, and national support as needed.

Note

1. *Mainstreaming* refers to integrating climate adaptation (preparing for and responding to climate impacts) actions as well as natural disaster risk management (multi-hazard, including nonmeteorological) into local urban and development planning processes.



Sensitization

Before a city can begin the technical aspects of developing a local resilience action plan, it is important to first raise awareness and gather broad-based support for the initiative. The LRAP methodology will take time, and will require staff, relationships with technical institutes, community outreach, and funding. The city government must understand the importance of developing an LRAP, given its specific context, and commit a dedicated team to undertake the effort. This chapter discusses the first three steps in developing an LRAP, which together constitute the sensitization phase (see figure 2.1).

SENSITIZATION
1. Conduct qualitative vulnerability self-assessment
2. Establish links to city vision and strategy
3. Establish an LRAP team

3.1 STEP 1. Conduct Qualitative Vulnerability Self-Assessment

This step is accomplished through a roundtable meeting of stakeholders.

3.1.1 Convene a Multi-Agency, Multi-Stakeholder Roundtable

The city government should take the lead in convening a roundtable of selected representatives from various departments, including both policy makers and technical staff. The departments represented should include agriculture, environment, urban development, construction/public works, planning, investment, finance, climate change, disaster risk, transport, water supply and

drainage, housing, and other infrastructure services providers. Representatives from business associations and civil society organizations, community groups, as well as technical institutes and universities, may also be considered as additional participants. To encourage discussion, there should be no more than 20–25 participants at the roundtable. At least half a day should be allotted for the proceedings.

Facilitator

It is important that whoever is appointed as the roundtable's facilitator be seen as impartial, inclusive, and encouraging different viewpoints to be heard. Consider separating the role of the chair from that of a (hired) technical facilitator.

The facilitator should be responsible for the overall scope and direction of the meeting. This would include establishing an agenda (see checklist 1 for an example); inviting participants and speakers; providing background materials to participants well in advance of the meeting; arranging for an opening presentation that gives participants an overview of the main issues to be discussed; setting goals for what is to be accomplished; steering the discussion so that it remains focused on the tasks at hand; and, to the extent possible, encouraging consensus so any conclusions are reached in a collective, nondivisive manner.

Checklist 1 Sample Agenda for First Roundtable

- ☑ High-level endorsement
- ☑ Overview of risks facing the city
- ☑ Hotspot exercise in working groups
- ☑ Presentation of programs at the department level on disaster risk management/climate change adaptation
- ☑ Consolidated hotspot matrix
- ☑ Discussion of key vulnerabilities
- ☑ Agreement on establishment, composition, and mandate of LRAP team as well as schedule
- ☑ Commitment to implementation

Context and Overview

A local expert should provide the roundtable with an overview of the existing hazards the city is exposed to and the new risks that climate change may pose. In Vietnam, for instance, this expert could be from the Department of Flood and Storm Control, the Hydrometeorological Institute, the Vietnam Institute of Meteorology, the NTP-RCC Standing Office, or a local university. This presentation will provide basic information to raise awareness at the roundtable of the need for proactive planning. Note that in some cities, it may be necessary to have an international expert to provide credibility to the discussion. For instance, in China, the Ningbo government was not aware of the climate risks the city faced until international studies were presented.

Terminology

Basic terminology should be clarified so that everyone can participate in the roundtable discussion and to promote understanding of basic climate change terms and concepts (table 3.1). A common understanding of the terms that apply to climate change impacts and consequences—and the differences between them—is critical to plan preparation. Understanding what contributes to climate change and the differences in the concepts of hazard, risk, vulnerability, and disaster is a first step toward understanding what cities will need to deal with in preparing their LRAP.

Table 3.1 Disaster Risk Mitigation and Climate Adaptation Key Terms

Term	Basic definition	Function of
Vulnerability	Degree of **susceptibility** of a system (community/asset) to the damaging effects of a natural hazard in a given environment	Hazard, exposure, adaptive capacity
Adaptive capacity	Ability to minimize potential impacts of disasters by undertaking ex ante **proactive** measures, including strengthening response systems	National policy frameworks, local institutions/regulations, risk information/technical expertise, exposure
Hazard	**Threat** of a dangerous natural event with the potential for causing losses and damages (if it occurs)	Physical conditions, geological, hydrometeorological factors
Exposure	Degree of **susceptibility** to potential losses for a particular hazard given the environment	Hazard, built environment, location of population and assets, mitigation infrastructure
Disaster risk	**Probable** value of losses that will occur in the event of a disaster	Hazard, exposure, vulnerability
Disaster	Effect of a hazard (the actual **event**) that results in losses and the extent to which critical functions in the city are disrupted; types of disasters include flood, storm, landslide, drought, volcanic eruption, earthquake, extreme temperature, and fire	Hazard frequency and intensity, exposure, vulnerability
Catastrophe	An **extreme** disaster that results in heavy losses	Disaster intensity, exposure, adaptive capacity
Loss	The value of disruption to the flow of goods and services caused by damages resulting from disasters (**indirect effect**); this includes loss of life	Damage, exposure
Damage	The **direct effect** of disasters that negatively affects physical assets	Disaster, adaptive capacity, vulnerability

Source: Authors.

Vulnerability refers to the degree to which a community is affected by natural hazards. It is a function of the community's hazard profile and exposure to potential losses from hazards, but also of its adaptive capacity. There are various dimensions to vulnerability, including

- physical (relating to the built environment),
- economic (affecting livelihoods),
- social (relating to particular community groups), and
- regulatory (to do with the existence and capacity of institutions and regulations pertaining to disaster risk reduction and their enforcement).

Vulnerable social groups include the elderly as well as children, women, people with disabilities, ethnic minorities, and the poor. These groups are prone to proportionally larger losses because of relatively limited incomes and assets, physical limits on their ability to evacuate and/or withstand disaster impacts, and/or occupation of residences that are not structurally sound or are located on marginal and flood-prone land.

The concept of **resilience** is inversely related to vulnerability. Essentially, resilience refers to the capacity of a community to adapt when exposed to a hazard. **Adaptive capacity**, then, is at the heart of resilience. The adaptive capacity of a city is related to taking proactive measures to reduce potential disaster impacts before they occur as well as in having the ability to rebuild after disasters.

Factors influencing local adaptive capacity include

- **local institutional, policy, and regulatory capacity** related to disaster risk management, climate change, land use and building controls, economic strength and diversification, financial resources and ability to generate revenues locally/from markets, infrastructure standards, and adequate provision of municipal services;
- **availability of data and technical expertise** in analyzing trends related to hazards; and
- **national and provincial policy frameworks** related to disaster prevention, climate adaptation, construction, and planning, including transfers of financial and technical resources to the city level.

3.1.2 Understand Links between Climate Change and Disaster Risk Management

In addition to understanding terminology, participants also must be able to grasp the relationships between climate change and disaster risk management. The essential point for participants to understand is that **climate change almost certainly will increase the frequency and intensity of the types of natural disasters that are most common in their area** (in Vietnam, this is primarily typhoons and other tropical storms) and could introduce new risks such as disease epidemics and physical risks to areas previously unexposed (box 3.1).

It is important to recognize that regular seasonal flooding, storms, or landslides may be disasters but may not reflect climate change per se. Climate change refers to changes in the predictable climate over time. For instance, looking at annual mean temperature changes, precipitation changes, and changes in sea level at specific points over several decades can demonstrate that the climate has indeed been changing (box 1.1).

Preparing for climate change can be tricky, especially because of the uncertainties associated with various models. Some cities, like London, have therefore taken the approach of incremental structural defenses that can be developed for a number of climate scenarios. Others have chosen to adopt standards for worst-case projections; of course, not many cities—especially in developing countries—can afford to take this route. What is important to rec-

Box 3.1 Asia and Rising Sea Levels

Many cities in Asia are likely to experience the consequences of rising sea levels linked to climate change. For instance, a rise of 1 meter in mean sea level (now considered by many scientists to be probable by 2100) could displace 10 percent or more of Vietnam's current population. Out of 136 port cities of over 1 million population with high exposure to coastal flooding due to storm surge and damage from wind flooding in 2070 (as a result of climate change), 4 of the top 10 in terms of exposed population are in East Asia—Guangzhou, China; Ho Chi Minh City, Vietnam; Osaka-Kobe, Japan; and Shanghai, China (Nicholls et al. 2008). It is forecasted that the sea level rise would accelerate storm surges and flood disasters in the Yangtze River Delta. Because of sea level rising, Ningbo, China, is ranked as one of the most vulnerable cities, given its high socioeconomic assets (ranked 14th) and population exposure (ranked 11th) (Nicholls et al. 2008). It is expected that Ningbo will experience high absolute exposure; large-scale flooding could affect substantial portions of the city's infrastructure, population, and socioeconomic activity. Therefore, the city's LRAP was prepared to support Ningbo's path toward resilience.

ognize is that while raising awareness regarding climate change is important, it should not detract attention away from "regular" hazards. Thus, priority should be given to addressing seasonal flooding caused by development failures such as clogged drainage, silted riverways, poor building codes, informal settlements in areas that should not be inhabited, and so on. In the Manila metropolitan area, for example, the risks from a storm with a 2-year return period are several times higher than those from one with a 30-year return period.

Disaster risk can be managed by taking steps that reduce the potential impacts of disasters, such as building dikes and preventing construction of housing and infrastructure in flood-prone areas. Disaster risk management can reduce the need for climate adaptation. However, not all climate change results in disasters; similarly, disaster risk management can cover disasters other than those that are climate-induced (e.g., seasonal flooding, seismic activity). Understanding these nuances is important to identifying the actors that could be involved in reducing vulnerabilities and the actions that could be taken. The objective of the LRAP process is to identify vulnerabilities and plan ways to reduce the impact of natural disasters in the future.

3.1.3 Conduct Hotspot Assessment

After participants have absorbed the basic relationships among climate change, natural disasters, and disaster risk management, the next task for the roundtable is an overall assessment of the city's vulnerabilities. This can be accomplished using the City Typology and Risk Characterization (or the Hotspot Assessment) Matrix. The template for this matrix was designed for the *Climate Resilient Cities* primer (Prasad et al. 2009); a blank matrix is included at the end of this workbook (template 1), and a completed sample for Hanoi appears in appendix B.[1]

At the beginning of this exercise, many participants likely will think they already know the city's vulnerabilities. By going through the exercise, however, participants may come to a fuller understanding of the city's vulnerabilities to natural disasters now and in the future. Participants will learn the interconnections among hazards, the built environment, population dynamics, the economic base, and the administrative structure that are part of the city's risk profile. With this information, they will be better able to move on to the next stages of determining how to reduce those vulnerabilities.

Objectives/Key Concepts

Following are the key objectives of the hotspot assessment:

- Identify major problem areas for climate change impact and disaster risk management as a step toward identifying priorities for action.
- Identify climate change and disaster risk management systems and determine their capacity to continually update their capabilities.
- Generate awareness among local government officials and other stakeholders about the important contributors to climate change and disaster risk management.
- Assist local government and other stakeholders in intuitively establishing the links between climate change impact, disaster risk management, and urban governance.

The Hotspot Assessment Matrix is divided into 11 categories of attributes (A–K) in three main areas: city description, political and economic impacts, and natural hazards and climate change. Following is a guide to filling out each of these sections.

City Description

Category A identifies the geographical location of the city. This helps identify the impacts of climate change and the likely natural hazards that are of concern to the city. A city may have multiple characteristics—for instance, it may be coastal *and* mountainous *and* near a fault line. The answers to these questions produce general information about geographical and topographical vulnerabilities to be addressed later in the exercise.

A. City description	
1. City location	
a. In a coastal area? (Y or N)	
b. On or near mountain area? (Y or N)	
c. On inland plain? (Y or N)	
d. On inland plateau? (Y or N)	
e. Near to or on a river(s)? (Y or N)	
f. Near earthquake fault lines? (Y or N)	

Category B identifies the size and main characteristics of the city's area and population. "Resident population" refers to permanent residents (i.e., night population). "Floating population" refers to migrant day-workers and others with no permanent residence in the city but who, nevertheless, are important to account for in the event of a disaster during the daytime. The definitions of very high (VH), high (H), medium (M), and low (L) should be verified at the beginning of the vulnerability self-assessment with the roundtable participants. The facilitator should evaluate the applicability of the definitions provided in the matrix for the particular city depending on its size and area, and modify these as necessary.

B. Size characteristics of city	
1. Resident population (VH, H, M, or L)	
VH = Greater than 5 million H = 2 million–5 million M = 0.5 million–2 million L = Less than 0.5 million	
2. Population growth during last 10 years (H, M, or L)	
H = Greater than 10% M = Between 2%–10% L = Less than 2%	
3. Floating population (VH, H, M, or L)	
VH = Greater than 30% of resident population H = Between 20%–30% of resident population M = Between 10%–20% of resident population L = Less than 10% of resident population	
4. Area in square kilometers (km^2)	
5. Maximum population density (day or night) (H, M, or L)	
H = Greater than 2,000 persons per km^2 M = Between 1,000–2,000 persons per km^2 L = Less than 1,000 persons per km^2	

Category C relates to the existing governance structure and disaster risk management in the city. To have a disaster risk department is critical to development of the LRAP. This department can be the focal point for action development and implementation and can be held accountable for the program. Moreover, if the disaster risk department is linked with the environment department, or any other department dealing with climate change issues, this coordination can increase the effectiveness of the initiative by avoiding asymmetry in information and duplication, while leveraging departments' competencies, skills, and experiences.

C. Governance structure as related to disaster risk management	
1. Appointed head of government? (Y or N)	
a. Term of assignment (Years)	
2. Elected head of government (Y or N)	
a. Term of elected officials (Years)	
3. Local government office structure: does it have…	
a. Disaster risk management department? (Y or N)	
b. Environment, sustainability, or climate change department? (Y or N)	
c. Are (a) and (b) in the same department? (Y or N)	
4. Other government office structure (state, national)*: does it have…	
a. Disaster risk management department? (Y or N)	
b. Environment, sustainability, or climate change department? (Y or N)	
c. Are (a) and (b) in the same department? (Y or N)	

Category D builds on the previous section and seeks to determine if the city has clear responsibilities for disaster risk management and climate change management.

D. City management on climate change and disaster risk management	
1. Responsibilities clearly specified? (Y or N)	
2. Responsibility for climate change management established? (Y or N)	
3. Responsibility for disaster risk management established? (Y or N)	
4. Authority to contract for services? (Y or N)	

Category E focuses on the city's overall financial resources. The ability to generate revenue locally will determine whether resilience measures can be financed.

E. Financial resources	
1. Total budget	
2. From local taxes and levies (% of total)	
3. From state/national government grants and devolutions (%)	
4. From domestic market (%)	
5. From international market (%))	
6. From external or multilateral lending agencies (%)	

Category F relates to the city's built environment and elicits information useful for determining the physical vulnerabilities of the city. The volumes and levels noted in the matrix can be modified by the facilitator to suit the city's actual size and area.

F. Built environment	
1. Does the city have urban growth master plans? (Y or N)	
2. Does the city have urban development and land-use plans? (Y or N)	
a. Population in authorized development (% of total)	
b. Population in informal or temporary settlements (% of total)	
c. Population density of informal settlements (H, M, or L)	
H = Population of informal settlements >20% of total M = Population of informal settlements <20% but >10% of total L = Population of informal settlements <10% of total	
d. Population in old tenements and historical development (% of total or H, M, or L using ratings in 2c)	
3. Does the city have building codes? (Y or N)	
a. What is level of compliance? (% compliant buildings)	
4. Observed vulnerability of buildings in past natural disasters (extent of disruption of building functionality)	
a. Informal buildings (H, M, or L)	
H = >15% of informal buildings highly vulnerable M = 5%–15% of informal buildings highly vulnerable L = <5% of informal buildings highly vulnerable	
b. Historic buildings (H, M, or L)	
c. New and formal developments (H, M, or L)	
H = >5% of new and formally developed buildings highly vulnerable M = 1%–5% of new and formally developed buildings highly vulnerable L = <1% of new and formally developed buildings highly vulnerable	

Political and Economic Impacts

Category G looks at the political impact of a disaster affecting the city. If the city is a national or provincial capital, the impact of disasters can be magnified because of potential adverse impacts on national or regional economies.

G. Political impact of disasters	
1. Is the city a national/provincial capital or where a large number of decision makers live? (Y or N)	
2. Is impact of disaster in the city likely to influence political activity in areas far away from affected regions? (Y or N)	

Category H establishes the impact of disasters on the most relevant urban economic activities of the city. As used here, "major" means that those specific sectors are present in the city and each account for at least 10 percent of local employment or at least 15 percent of income generation.

H. Economic impact of disasters	
1. Is the city a major center of economic activity in regional or national context? (Y or N)	
2. Do the following sectors have major activity in the city?	
a. Industrial sector? (Y or N)	
b. Services sector? (Y or N)	
c. Financial sector? (Y or N)	
d. Tourism and hospitality sectors? (Y or N)	
e. Agriculture, aquaculture, and rural sectors? (Y or N)	

Natural Hazards and Climate Change

Category I assesses the threat to the city of several types of natural hazards. For most hazards, the information will be available from building regulations and past meteorological records (going back approximately 50 years). Seismic, tsunami, and volcanic hazards are very important since they occur after long intervals and may not have occurred during the last 50 years.

I. Threat of natural hazards	
1. Earthquake? (Y or N)	
2. Windstorm? (Y or N)	
3. River flood? (Y or N)	
4. Flash rainwater flood or extreme precipitation? (Y or N)	
5. Tsunami? (Y or N)	
6. Drought? (Y or N)	
7. Volcano? (Y or N)	
8. Landslide? (Y or N)	
9. Storm surge? (Y or N)	
10. Extreme temperature? (Y or N)	

Category J relates to the existence, capacity, and effectiveness of the city's emergency response plan.

J. Disaster response system	
1. Does a disaster response system exist in the city? (Y or N)	
2. Is the response system comprehensive and equipped for all natural hazards specified? (Y or N)	
3. Is the disaster response system regularly practiced? (Y or N)	
4. Is the disaster response system regularly updated? (Y or N)	

Preparedness can be further investigated by hazard type within each sector of the economy (table 3.2).

Table 3.2 Vulnerability Assessment: Level of Preparedness/Readiness by Hazard Type and Sector

Hazard type	Sector		
	Industrial	Services	Financial
Earthquake (H, M, or L)			
Windstorm (H, M, or L)			
River flood (H, M, or L)			
Flash rainwater flood or extreme precipitation (H, M, or L)			
Tsunami (H, M, or L)			
Drought (H, M, or L)			
Volcano (H, M, or L)			
Landslide (H, M, or L)			
Storm surge (H, M, or L)			
Extreme temperature (H, M, or L)			

Source: Authors.

Note: Rate the level of preparedness for each event for each sector. H = high level of preparedness and readiness to respond to disaster and hazard; M = somewhat high level and the basic/key informants are present (a basic disaster management system is in place, but may not be comprehensive or consider specific hazards); L = low (no disaster management system, no warning system, etc.).

Category K relates to the potential impact on the city of climate change. The impact, related to several sectors, may be known from detailed scientific investigations or from empirical data and field observations.

K. Climate change impacts	
1. Is the impact of climate change on the city known? (Y or N)	
2. Are the following sectors vulnerable to the consequences of climate change?	
a. Built environment? (Y or N)	
b. Cultural and religious heritage? (Y or N)	
c. Local business, industry, and economy? (Y or N)	
d. Energy generation and distribution system? (Y or N)	
e. Health care facilities? (Y or N)	
f. Land use? (Y or N)	
g. Transportation system? (Y or N)	
h. Parks and recreation areas? (Y or N)	
i. Tourism? (Y or N)	
j. Agriculture and rural? (Y or N)	
3. Is climate change assessment based on local studies instead of regional/ global models? (Y or N)	
4. Does the city have a climate change strategy (maybe as a component of national policy)? (Y or N)	
5. Does the city have climate change programs in place? (Y or N)	
6. If yes, do the climate change programs consider:	
a. Mitigation? (Y or N)	
b. Adaptation? (Y or N)	
c. Resilience? (Y or N)	

It may be worth looking at specific climate impacts by sector within the city to determine what kinds of adaptation strategies may be most relevant (table 3.3).

Table 3.3 Vulnerability Assessment: Specific Climate Factors by Sector

Sector	Temperature rise	Precipitation change	Sea level rise
Built environment (H, M, or L)			
Cultural and religious heritage (H, M, or L)			
Local business, industry, economy (H, M, or L)			
Energy generation/distribution (H, M, or L)			
Health care facilities (H, M, or L)			
Land use (H, M, or L)			
Transportation system (H, M, or L)			
Parks and recreation areas (H, M, or L)			
Social equity system (H, M, or L)			
Water management (H, M, or L)			
Tourism (H, M, or L)			

Source: Authors.

Note: Rate the level of vulnerability in each sector. H = very important consequences and priority for action; M = important and should be considered in city development plans; L = unimportant.

Interpretation of Exercise

The city can establish its level of vulnerability and decide on initial directions for priority actions based on the assessment. Since the Hotspot Assessment is a self-assessment exercise, the city can assign different levels of importance to the various sections of the matrix based on its own priorities. The indicative importance of various factors is given in checklist 2, which shows the key elements that establish a high potential impact of climate change and natural disasters.

The exercise can be followed by a discussion to identify hotspots in the city based on parameters from the exercise; these hotspots represent specific areas or sectors of a city that are particularly vulnerable to natural disasters present or future because of their topology, socioeconomic factors (such as density of population and assets in the areas), or other factors. Examples might include high-density neighborhoods, temporary housing areas or slums, industrial zones, areas affected by drought, vital roadways prone to flooding, and low-

level areas or river basins that can be inundated. A particular community or group of people (e.g., the elderly or the poor), especially during an emergency situation, or a sector (food production, tourism, electricity supply, telecommunication network, etc.) also could be considered a hotspot.

The hotspot assessment helps the city articulate its priorities and actions for the short, medium, and long term. The assessment also helps provide the motivation for implementing various "no-regret" programs (actions that will prove beneficial for reasons other than reducing vulnerabilities). Other longer-term programs are often difficult to justify solely based on climate change considerations since their impact on climate change is difficult to quantify. The simple methodology used in the Hotspot Assessment Matrix can provide intuitive justification for such programs.

The hotspot assessment is a very important tool in informing and raising awareness among city officials—as well as among other stakeholders from ward and community organizations, unions, and NGOs—about climate change effects and disaster risk management capabilities in the city and to engage the larger community in awareness campaigns. The assessment can also be used to evaluate the likely impacts of ongoing and proposed programs and determine their likely impact on the city's vulnerabilities from climate change and natural disaster considerations. This initial exercise will set the foundation for the subsequent steps in the workbook.

Checklist 2 Establishing a City's Vulnerability

- ☑ Moderate to high level of one or more natural hazards
- ☑ Medium or high observed vulnerability in past disasters
- ☑ Moderate to high sectoral vulnerability of climate change
- ☑ Poor or nonexistent urban development plan or growth plan
- ☑ Poor compliance with urban development plan or growth plan
- ☑ Poor quality of building stock
- ☑ High population density
- ☑ Medium to large population or high decadal growth rate or high population density in case of low population
- ☑ Medium or high slum density or large proportion of informal housing
- ☑ Lack of comprehensive disaster response system
- ☑ Economic and/or political significance in regional or national context

3.2 STEP 2. Establish Links to City Vision and Strategy

The LRAP process must be undertaken in the context of the city's development goals, rather than as a completely independent activity. A city may even have a particular vision—for instance, to be the tourism hub of Vietnam, or the garment port for the region, a more industrial city, an all-inclusive city for residents, and so on.

A vision is a model of the future for a city and its inhabitants. It is a strategy for the development of spatial and settlement structures, and a test routine for everyday decisions and actions. To develop a vision, many cities have been performing **visioning exercises**, an increasingly popular technique that develops goals for the future of a city through consensus-based meetings open to all parties. In some cases, the LRAP process may necessitate a visioning exercise in itself (box 3.2).

Starting from the city's broad growth and development goals and then assessing the obstacles potentially posed to these by disasters and climate change will yield stronger results and a greater appreciation of the process than will starting from disaster prevention as a goal in and of itself.

A scenario planning exercise is sometimes used in this process. This is an analytic method used for exploring the potential impacts that particular hazards (or a combination of them) could have on a city's ability to realize its vision under the current status quo versus an alternative scenario in which proactive disaster risk mitigation measures are employed.

Box 3.2 City Vision and Visioning Exercises

The primary purpose of this exercise is to develop an overriding vision for the city in the future based on a broad community consensus. The vision also should provide a plan with a short- and long-term implementation guide for government, civic groups, businesses, and resident stakeholders related to land use and zoning, residential areas, transportation, design, future development, and general renewal. The exercise incorporates the following:

- **Stakeholder consultation.** Various stakeholders should be invited to and engaged in the visioning process, including city officials, NGOs, the private sector, members of regional and national government, academia, think tanks, and so on.
- **Visions showcase and vision plan.** Presentations should be made explaining the visioning process to the stakeholders (in workshops or meetings); this entails
  - **understanding the city's current situation:** which are the main vulnerable areas and sectors and what can be changed in the future; which are the fast growing areas and sectors, the most popular services, and so on
  - **generating possible scenarios:** presenting different growth paths for the city, focusing on different sectors—economic and social growth, poverty eradication, infrastructural development, and so on
  - **drafting a vision plan** based on discussions among stakeholders about the possible development paths
  - **agreeing** on the most desirable and applicable path for the city and proposing the final vision plan to the city government
- **Putting ideas into practice.** Develop an operational action plan with an implementation section outlining the steps to be taken to use these strategies practically in the community.

Depending on the technical capacities available, this exercise can be done in broad qualitative terms or by quantifying projections in terms of growth in populations and built-up areas as well as future hazard risks. The level of technical complexity should be in line with what the city can comfortably understand and replicate. Dakar, Senegal, used complex technical projections but had limited capacity for replication, reducing the utility of the exercise.

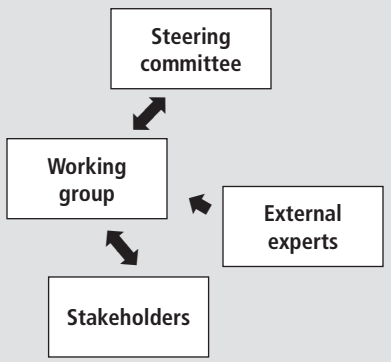
Based on the results of the qualitative vulnerability self-assessment, the next step is to identify the issues that might hinder achievement of a city's vision and development strategy. This step looks for particular hazards that are of special concern and whether certain areas of the city, or certain communities or economic sectors, are especially exposed. With these problems identified, the exercise determines what kinds of actions need to be taken to reduce vulnerabilities—and how those actions fit into the city's long-term vision and strategy.

3.3 STEP 3. Establish an LRAP Team

A logical and effective next step is to establish a dedicated team that will guide the development of the LRAP. The LRAP team should manage information collection and analysis; establish agendas for and hold periodic meetings with city officials, other stakeholders, and communities to discuss issues it has identified; and facilitate city work sessions to develop and carry out priority initiatives.

The LRAP team should include four levels of representation: (1) high-level policy makers who can take decisions and mainstream actions into city plans and management functions (**steering committee**), (2) technical bureaucrats who can be assigned the day-to-day tasks required for developing the LRAP (**working group**), (3) a **panel of experts** who are available to the working group for specific technical inputs, and (4) a set of **representatives from various stakeholder and community groups** that will be consulted periodically (figure 3.1).

Figure 3.1 The LRAP Team



Source: Authors.

Checklist 3 Defining the LRAP Team Structure

- ☑ Identify and discuss team structure
- ☑ Discuss team committee membership to ensure inclusion of a variety of entities and community members
- ☑ Discuss and agree on a recommended team committee structure
- ☑ Discuss and agree on team committee membership
- ☑ Discuss and agree on illustrative committee responsibilities

Checklist 4 Questions to Consider in Forming the Team

- ☑ What are the team's terms of reference—that is, what is its mandate?
- ☑ What is the team empowered to do? What kinds of decisions can it make on its own, and what decisions need to be referred to a higher level?
- ☑ What agencies and organizations should be represented on the team?
- ☑ Who appoints the team members?
- ☑ How often should the team meet?
- ☑ Does the team have a deadline for completing its work?
- ☑ What staffing and financial resources are needed?
- ☑ How and when will community representatives be brought into the process?

3.3.1 Considerations in Creating the LRAP Team

Because the LRAP team will have a central role in planning a climate-resilient future for the city, deciding who to appoint to the team will be important (checklist 3). The goal should be to choose individuals who represent key constituencies, both in the city government and in the broader community, and who will play an active role in ensuring the process is undertaken responsibly and diligently. The success of LRAP development initiatives will depend on the degree of community ownership of what is to be done and an understanding of why and how an initiative is to happen. Establishing a city team involves national and local government, local community, private sector, academic, and NGO participation (checklist 4). An example of an LRAP team structure from Can Tho, Vietnam, is presented in appendix C.

3.3.2 Creating the LRAP Team

The Steering Committee

The first level of representation that should be included on the LRAP team is high-level policy makers, which means heads of all relevant departments—environment, construction, trade and industry, policy and investment, finance, transportation, agriculture, and so on—who can take decisions and mainstream actions into city plans and management functions. The steering committee should be chaired by the highest-level person on the committee, such as the vice chairman of the city or the deputy mayor.

The LRAP team need not displace existing institutions or create parallel bodies with overlapping mandates. However, where no such body exists, city steering committees established to address climate change as an ongoing responsibility should be considered to be a permanent local government function.

The mandate for such committees should include the following:

- Define and show commitment to the development and implementation of climate-resilient initiatives in the city by chairing, giving speeches on, and participating in the launch event of these programs, calling the most important meetings of the LRAP team, and keeping appointed persons accountable for results
- Outreach to engage stakeholders in informed discussion to set priorities, and in project design and implementation
- Monitoring and evaluation of preparedness, growth, and mitigation and adaptation initiatives.

The Working Group

The second level of representation that should be included on the LRAP team are the city officials and technical bureaucrats who can be given the day-to-day tasks required for developing the LRAP. These officials will comprise the working group. The technical experts will belong to all relevant departments and will have access to all relevant and available information, data, and maps. In Ningbo, China, the LRAP team consists of many city officials from more than 10 departments and other experts from the National Meteorological Bureau and other technical/scientific organizations formally separated from the municipal departments, but significant to data compilation and projections. In Yogyakarta, Indonesia, the LRAP team was lead by the regional body for planning and development, with strong participation from community leaders and local stakeholders, such as NGOs, community associations, universities, and research institutions.

External Experts and Stakeholders

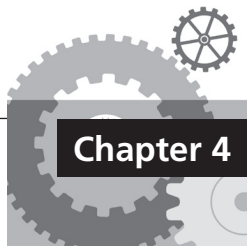
The remaining levels of representation included on the LRAP team are a panel of experts who are available to the working group for specific technical inputs, and representatives from various stakeholder and community groups available for periodic consultation.

Partnerships with local universities, technical institutes, and other agencies with technical expertise and knowledge about the community's vulnerabilities and needs are essential in understanding the hotspots, defining vulnerabilities and main risks, creating projections of future impacts of climate change and natural disasters, and integrating these projections into the

planning process. Such partnerships provide long-term stability to the LRAP process and are useful in helping to determine the city's long-term climate resilience priorities which span across the terms of officials and governments.

Note

1. The *Climate Resilient Cities* template can be downloaded at www.worldbank.org/eap/climatecities.



Chapter 4

Technical Analysis

TECHNICAL ANALYSIS
4. Conduct city-scale spatial analysis
5. Identify target areas
6. Conduct spatial analysis of each target area
7. Identify specific vulnerabilities

The first task of the LRAP team working group is to collect data and information from various departments. This information is used to undertake spatial analysis of the vulnerabilities the city faces. This chapter discusses LRAP steps 4–7 (see figure 2.1).

Spatial analysis is a good way of aggregating data into visual representations; such representations are powerful tools for understanding vulnerabilities, conducting community outreach, and engaging policy makers and donors so as to influence the city's capital improvement programs and capacity-building efforts. The spatial analysis is accomplished by first compiling the required information in maps (appendix D presents a sample set of such maps for Can Tho, Vietnam). These maps capture information on the current description of the city in terms of administrative boundaries, land use, people, and the economic assets and locations prone to various hazards. The maps also illustrate the future vision of the city which is used to evaluate the changing profile of the city and the need for undertaking resilience measures.

4.1 STEP 4. Conduct City-Scale Spatial Analysis

The base information is first collected for the entire city in broad terms and subsequently in more detail in target area maps, usually developed at the ward

or commune levels. The recommended scales used for the mapping exercise in Vietnam are as follows:

- Wards and villages
  - <150 ha: 1/1,000
  - 300–2,000 ha: 1/5,000
  - 150–300 ha: 1/2,000
  - >2,000 ha: 1/10,000
- Districts
  - 2,000–10,000 ha: 1/10,000
  - >10,000 ha: 1/25,000
- Provinces and cities: 1/50,000

The maps described in this chapter should be developed based on available maps from which the requisite information can be extracted.

A useful starting point for preparation of the macromaps is a city land use map. City and state agencies that provide basic services may have distribution lines and service levels. Business groups, unions, and chambers of commerce may have economic data; and planning agencies may have future growth plans and information. Inventory existing data against the data requirements for each map. Data sources include national and city censuses, hospital records, universities and schools, religious institutions, district and city planning offices, and the ministry of construction, to name a few. Consult with technical support entities for existing predictions and projections made for climate change impacts and consequences.

4.1.1 Compile City-Scale Current Status Macromap

The current description of the city can be displayed on a number of maps, each with a different theme and each comprising a separate layer of the current status macromap. The following mapping layers are suggested for compilation of the current information needed for LRAP development:

- Baseline map
- Socioeconomic map
- Hazard profile map

Brief descriptions of each map follow. The aggregation of these maps provides a composite picture of the city's current existing exposure.

City Baseline Map

The city baseline map shows the city's administrative boundaries, physical characteristics (such as rivers and hills), and roads and other major infrastructure elements (checklist 5).

City Socioeconomic Map

The socioeconomic map identifies population location and density, land use (including residential, commercial, industrial, agricultural, and administrative districts and green areas), high-value assets (e.g., economic zones and cultural heritage sites), critical infrastructure (schools, hospitals, etc.), and concentrations of poor people/slums that are particularly vulnerable to the effects of natural disasters. The maps should show both pockets of poverty and vital commercial and industrial areas (checklist 6). If possible, an estimate of the monetary value of the assets and people at risk (using, e.g., average land values as a proxy) should be calculated.

City Hazard Profile Map

The city hazard profile map shows the areas of the city that historically have been most affected by natural disasters, such as flooding (box 4.1) or wind damage. The LRAP is based on a multi-hazard approach to hazard management, and the hazard profile map should reflect multiple hazard scenarios. Ideally, then, it should be composed of several individual maps showing flood, earthquake, landslides, and so on. Where possible, exposure mapping should be undertaken based on historical records. Suggested information to include in compiling the city's hazard profile map is listed in checklist 7.

The hydrometeorological hazards that may be affected by climate change and variability such as floods, storm surges, typhoons, and sand and dust

Checklist 5 Information to Include in City Baseline Map

- ☑ City boundaries and submunicipal boundaries (e.g., districts, wards)
- ☑ Topography: elevation, water bodies
- ☑ Major roads
- ☑ Major infrastructure: water supply, sanitation and sewerage, roads, highways, bridges, ports, power supply, among others
- ☑ Natural elements, mangrove, hills, rivers, plantations, among others

Checklist 6 Information to Include in City Socioeconomic Map

- ☑ Urbanized and vacant areas
- ☑ Land use designations including commercial, industrial, and residential areas
- ☑ Economic activities including commercial zones, fishing areas, grazing land, farms, central business districts, hotels, and tourist facilities
- ☑ Industrial areas including ports, marinas, docks, fish farms, industrial zones, and factories
- ☑ Major community buildings, special-interest structures, community centers, religious buildings, historic/cultural assets, and so on
- ☑ Social services infrastructure, including schools, hospitals, and clinics
- ☑ Vulnerable populations including the elderly, children, handicapped, women heads-of-households, and low-income households.

Box 4.1 Flood Maps

Flooding is a result of heavy or continuous rainfall exceeding the absorptive capacity of soil and the flow capacity of rivers, streams, and coastal areas. This causes a watercourse to overflow its banks onto adjacent lands. Floodplains are, in general, those lands most subject to recurring floods, situated adjacent to rivers and streams. Floodplains are therefore "flood-prone" and are hazardous to development activities if vulnerability exceeds an acceptable level. Floods are usually described in terms of their statistical frequency. For instance, a "100-year flood" describes an event subject to a 1 percent probability of a certain size flood occurring in any given year. Frequency of inundation depends on the climate, the material that makes up the banks of the stream, and the channel slope. Where substantial rainfall occurs in a particular season each year, the floodplain may be inundated nearly every year, even along large streams with very small channel slopes.

A flood map should show flood risk zones and their boundaries. It may also show floodways and base flood elevations. Gathering hydrologic data directly from rivers and streams is a valuable but time-consuming effort. Without a record of at least 20 years, flood hazard assessments based on direct measurements may not be possible, because there is no basis to determine the specific flood levels and recurrence intervals for given events. Hazard assessments based on remote sensing data, damage reports, and field observations can be substituted when quantitative data are scarce. They present mapped information defining flood-prone areas that will probably be inundated by a flood of a specified interval. Digital elevation models are also used (see appendix E).

Source: Adapted from OAS 1991, chapter 8.

storms should be included. Others geophysical hazards such as earthquakes, tsunamis, and landslides should be included based on past experience or scientific assessment studies. The LRAP team may need to compile a disaster history and map important impacts in case this information is not readily available from city departments or from the local communities affected by the disasters. Hazard mitigation infrastructure should also be included on the aggregated hazard profile map so that critical gaps in existing mitigation infrastructure can be identified.

Checklist 7 Information to Include in City Hazard Profile Map

- ☑ Area affected
- ☑ Population affected, homeless, killed
- ☑ Housing destroyed and damaged
- ☑ Infrastructure and services damaged
- ☑ Economic impact
- ☑ Hazard mitigation infrastructure, including location of sea walls, dikes, retention ponds, and so on

4.1.2 Compile City Future Growth Macromap in Accordance with the City Vision

The city-scale current status macromap needs to be compared against a future growth map—perhaps 20 years out—based on metropolitan projections. The future growth map requires the same three types of input maps described above—a baseline map, including

projected changes to the administrative boundaries or physical elements and changes to infrastructure assets; a socioeconomic map, based on projected changes in population, economy, and land uses; and a hazard profile map based on expected changes due mostly to climate-induced factors. Checklist 8 lists the type of information to be included in this macromap.

The future growth map is based on the city's master plan, where available, or other planning and investment strategies, such as sectoral plans—for example, a transport growth plan to 2020. Information is also required on the changing hazard profile of the city due to its growth (projected population increases, changes in built-up areas, changes in land use designations, etc.) and to other factors such as climate change. The city's future growth strategy is typically the outcome of its future vision, and the spatial socioeconomic planning agenda is generally illustrated in the city's future master plan.

Several cities in Vietnam are growing in size as peri-urban areas are incorporated in the cities to enable integrated planning and consequent urbanization of more areas in the country. For example, Hanoi and Can Tho have recently been expanded to include the adjoining communities, thereby greatly increasing the respective city's boundaries. The future growth map should consider such expanded boundaries, and the current status maps should be prepared for the expected larger city, and not confined to the current city boundaries.

A city may choose to prepare additional annotated maps to address specific relevant issues, such as tourism assets; environmental assets that may require protection and/or maintenance; and individual economic activities such as fisheries, rice production, agrobusiness, and commerce. To this end, sector-specific maps or other thematic maps capturing specific and more detailed information may be prepared by the city depending on its priorities (see, e.g., the urban and industrial features socioeconomic map in appendix D). Additional maps could reflect the unique context and areas of concern that climate change may affect.

Checklist 8 Information to Include in City Future Growth Macromap

- ☑ Changes in the overall city's boundaries, due to peri-urban growth or formal reclassification, as well as administrative boundary changes within the city (e.g., changes to district boundaries)
- ☑ Planned investments in roads, highways, ports, public transport, water and energy supply and distribution, etc.
- ☑ Changes in land use designations
- ☑ Projected changes to population densities and economic activity
- ☑ Projected changes in location of vulnerable populations—e.g., growth in fragile areas
- ☑ Changes in intensity, frequency, and location of hazards based on hazard modeling—this may include new hazards (e.g., from sea level rise, coastal inundation) and changes to the profile of existing hazards (e.g., changing temperature and precipitation patterns)

The future growth map should include results of climate change projections to assess whether these will magnify existing vulnerabilities or introduce risks to new areas previously not highly vulnerable to disasters. Depending on the information available and/or the resources the city has to undertake additional analysis, country-level projections made by a national agency, research organization, or international agency may be extrapolated for the city; conversely, downscaling may be undertaken through more rigorous local modeling (discussed in appendix E).[1] Note that there is great uncertainty associated with climate modeling; consequently, it is sometimes better to instead model future scenarios and plan for measures under these different scenarios.

The mapping exercise is a participatory activity carried out by the city LRAP team. The team begins with existing information and adds new or better-quality information as needed but should not allow the lack of complete information to hinder preparation of a first-draft map as a starting point. The objective of the future growth map is to identify whether exposure and vulnerabilities are projected to increase in the future based on current plans, as these could keep the city from realizing its economic potential and development vision.

4.1.3 Analyze City-Scale Macromaps

The macromap refers to the consolidated spatial layers at city scale when all the maps are overlaid. It gives a snapshot of the entire city, its essential assets and vulnerabilities, and how these may be influenced in the future. The macromap allows planners to see whether population and economic growth need to be guided away from marginal areas, natural environment and historic urban areas are being protected, and whether adaptation infrastructure might be considered at key areas.

As explained above, the macromap is derived from existing documents, information, and available maps, as well as existing plans for changes in land use, administrative boundaries, new investments in infrastructure, and relocation of vulnerable settlements, among others.

When there are gaps in the data, a strategy to fill the gaps should be articulated. To generate the best estimates for missing information, the LRAP team should work with existing agencies responsible for sector-specific information and population data. It is not envisioned that long-term studies be carried out as part of this mapping effort; however, should a partner institution or agency wish to commit to a specific study or other data-gathering activity—for

instance, a city may decide to embark on a climate change downscaling exercise, or it may decide to use standard assumptions based on national studies—the LRAP team should monitor progress so as to be able to update the macromap once the new information is available. Considerations in gauging the completeness of the city macromap is given in checklist 9.

The layers of the macromap can be, but do not need to be, generated through computer software programs. If capacities exist for using geographic information system (GIS) data (box 4.2), ArcGIS or similar software could be used to accomplish the layering and to produce summary statistics—assets at risk, for instance (appendix F). If the city does not have access to technologies such as ArcGIS or AutoCAD, simple maps created with sketches on transparent plastic sheets or tracing paper and then manually overlaid will be sufficient (box 4.3). The key is to use whatever data and technologies are available to engage in this spatial analysis exercise, which is a key input to the LRAP.[2]

A consolidated list of vulnerabilities and gaps in current risk management systems should be drawn up based on the results of the city-level spatial mapping exercise and the discussions that follow. The list should indicate citywide disaster risk management and sustainable development issues; this becomes an input to the next step in the process. Citywide gaps could include things like early warning systems, capacity to forecast and analyze information, adequacy of the citywide drainage infrastructure, or land use guidelines and enforcement to control settlements along river embankments and other highly vulnerable areas.

Checklist 9 Assessing the City-Scale Macromap

- ☑ Does the macromap start from existing available maps?
- ☑ Does the macromap present the broad characteristics of the metropolitan area: administrative boundaries, topography (elevation, water bodies), available land and land use (commercial areas, residential areas, industrial areas, green areas), large-scale infrastructure and utilities, primary cultural assets, critical community facilities (especially schools, hospitals, and administrative buildings), concentrations of poverty/slums?
- ☑ Has the working group been divided into breakout groups to prepare specified maps and then presented their information to be included in the macromap?
- ☑ Has new information been added to the macromap about hazards and hazard mitigation facilities, future growth, and local and national plans and initiatives that may affect the city?
- ☑ Have priority vulnerable areas been identified through overlays and discussion? Did the spatial areas of focus change based on the different layers?
- ☑ Have gaps in the information to be mapped been identified and plans made to fill the gaps?
- ☑ Have hardcopy maps followed the specified formats?
- ☑ Has the macromap been prepared using a geographic information system (GIS) or with electronic mapping software (e.g., AutoCAD), if available?

4.2 STEP 5. Identify Target Areas

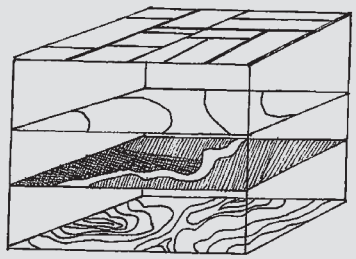
Using the macromaps, the LRAP team will identify the specific areas of the city that are perceived as the most

Box 4.2 What Is a Geographic Information System?

GIS technology was first applied when maps showing different kinds of information for the same area were overlaid to determine relationships. Since computer technology is progressing rapidly, examination of larger areas with an ever-increasing amount of data is now possible and affordable. Digitization, manipulation of information, interpretation, and map reproduction are tasks that can now be achieved rapidly, almost in real time.

The concept of a GIS is analogous to a very large panel made up of similarly shaped open boxes, with each box representing a specified area on the Earth's surface. As each element of information about a particular attribute (soil, rainfall, population) in the area is identified, it can be placed into the corresponding box. Since there is theoretically no limit to the amount of information that can be entered into each box, very large volumes of data can be compiled in an orderly manner. After assigning relatively few attributes to the box system, it becomes obvious that a collection of mapped information has been generated and can be overlaid to reveal spatial relationships between the different attributes—for example, hazardous events, natural resources, and topography (see figure for an example of such an overlay).

There are many kinds of GIS software, some more suitable for integrated development planning studies and natural hazard management than others. Those developed for the PC are the most affordable and are relatively simple to operate, capable of generating maps of varying scales and tabular information suitable for repeated analysis, project design, and decision making.



GIS applications in natural hazard management and development planning are limited only by the amount of information available and by the imagination of the analyst. Readily available information on natural events (e.g., previous disaster records), scientific research (papers, articles, newsletters, etc.), and hazard mapping (seismic fault and volcano location, floodplains, erosion patterns, etc.) are usually sufficient to conduct a GIS preliminary evaluation of the natural hazard situation and guide development planning activities.

Source: Adapted from OAS 1991, chapter 5.

vulnerable; these will become the target areas. Additional investigation will be conducted for each of these areas detailing the level of vulnerability in terms of assets, socioeconomic activities, and population. Detailed large-scale maps of the target areas will identify specific vulnerabilities and can be compared against current plans or programs to assess whether they are sufficient to reduce the vulnerability, identify gaps in addressing priority vulnerabilities, propose any additional options, and prioritize a set of actions to enhance resilience in those areas.

The target areas should be selected by the LRAP team based on the following criteria:

Box 4.3 Data Formats and Processing Options

Cities are likely to have the data needed to prepare their baseline and future growth maps in a variety of formats. Some cities make extensive use of GIS software such as ArcGIS or MapInfo for planning purposes. Other cities use mapping software such as AutoCAD for maintaining their planning maps. In some cases, the information may only be available in hard-copy maps. The spatial analysis should aim to use all available information regardless of the format in which it is available.

Data on climate change impacts are also available in a variety of forms and scales. In some cities, detailed downscaled projections for climate change impacts may be available. In cities where no city- or region-specific downscaling studies are available, the results from global studies such as those by the Intergovernmental Panel on Climate Change (IPCC) can be effectively used instead.

The overlaying process by which the maps are superimposed to identify the most vulnerable areas can be done manually using transparencies or tracing paper, or electronically by controlling the layers that are seen. Both processes can provide identical results if done carefully; the choice of the process will depend on the formats of the available maps.

The World Bank's Natural Disaster Risk Management Project in Vietnam supports, among other things, a GIS capacity-building program to develop and implement sustainable GIS capability through the provision of basic and advanced capacity building, and of appropriate hardware, software, and consumables in the disaster management committee at the central level and the regional disaster management centers in Da Nang and Ho Chi Minh.

The introduction of an appropriate GIS—both at the central and regional levels—will significantly improve the quality, timeliness, and transparency of the risk assessment and analytical processes. It will also be beneficial for all agencies charged with the development of disaster-resistant infrastructure and the design of mitigation and preparedness measures.

1. Frequency of past hazards and their impact
2. Socioeconomic status
3. Economic, cultural, and commercial activities
4. Presence of significant administrative or military installations.

The relative importance of each criterion in the selection of the target areas should be established by the LRAP team through a consultative process involving the various stakeholders.

An LRAP team meeeting should be dedicated to the identification of the target areas. At this meeting, the macromap should be displayed, overlaid, and analyzed to identify the city's main vulnerabilities. The need for additional data, data availability, and the department/organization responsible for or possessing the required data should also be discussed during the meeting. This information about vulnerabilities and data availability should be used to formally select the target areas and make a recommendation to the concerned departments/organizations to share the required data for the purposes of the LRAP program.

For cities with a very high population density, each target area should not exceed 2–3 square kilometers and should follow a logical political boundary or be bounded by streets in such a way that the total population in a target area does not exceed approximately 100,000 people. For cities with medium to low population densities, the target areas may be much larger (up to 10 square kilometers) such that the population does not exceed 25,000–50,000 people. For cities with low population density, the target areas may be still larger to ensure that the population of each is at least 10,000 people. This determination should be made in a flexible way appropriate to the city's context. The size of target areas in Can Tho, Vietnam, is shown in appendix D. It is recommended that each target area in a city have different distinguishing characteristics in terms of the nature of the hazard, residents' socioeconomic status, economic activities, and administrative or military considerations.

Since the detailed analysis at the microlevel in selected target areas uses available data and maps at a large scale, it is important to ascertain the availability of the required information in the target area before its selection. The LRAP team should preselect possible candidates for target areas and ascertain the availability of required information and data for the preparation of detailed maps.

Additional target areas can be added to the LRAP over time, but should not hold up the process for at least a few initial target areas. Identification of these initial areas will demonstrate the value of spatial analysis in particular and the LRAP process in general so that this process can later be replicated and scaled up to additional areas. Depending on the time and resources available, and the city's priorities, several target areas could be assessed together comprising the entire administrative area of the city.

4.3 STEP 6. Conduct Spatial Analysis of Each Target Area

Once the target areas have been selected, the LRAP team should identify which members will be responsible for which maps. Rather than dividing the responsibilities according to target areas, it is more efficient to allocate responsibilities by thematic map. For instance, one group should prepare all the hazard maps for all the target areas chosen. This will help ensure consistency across maps and will channel experts according to their area of expertise.

The target area mapping process is very similar to the city-scale mapping described in Step 4, only the target area mapping is undertaken at a finer level

of resolution and in more detail since it is undertaken at the neighborhood scale.

4.3.1 Compile Target Area Current Status Maps

Information providing a current description of the target area can be displayed through a number of maps, with each map showing a different theme. These maps follow a similar structure to those prepared at the city level in Step 4. The following themes are suggested for compilation of current information required for LRAP development in the target areas: baseline map, socioeconomic map, and hazard profile map. A brief description of each is provided below. These maps may use data and information available from city departments as well as other sources such as universities or from past studies. Specific surveys in the area and interviews with ward/commune officials, district officials, and local stakeholders can help in detailing the target area maps. In Vietnam, each map was produced at a 1:2,000 scale; this may differ in other countries, based on the available data.

Target Area Baseline Map

The target area baseline map is the annotated graphic representation of the priority areas identified as the most vulnerable, recording the land resources and natural and built environment. It includes similar information to the city baseline map, but in more detail, with individual roads, footpaths, streams, and so on, visible.

Target Area Socioeconomic Map

This map shows the social characteristics and major economic activities of the target area (box 4.4). It uses the baseline map described above and overlays social and economic indicators, using different maps to present the social and economic profiles, respectively. The social profile map records social indicators consisting of disaggregated information on the target area population and density, the population growth rate, the location of vulnerable populations, and so on. The economic profile map records economic indicators illustrating the major economic activities, their locations, and so on.

Because a city has numerous social and economic indicators serving a variety of purposes, only those relevant to understanding the vulnerabilities of the city to climate change and disaster risk should be included in the socioeconomic map. It is recommended that the local government enter into a part-

nership with a local technical support entity, university, or institute to develop the predictions and projections for future climate change impacts on its social and economic fabric.

Several aspects of a target area's socioeconomic profile cannot easily be represented in maps. These aspects can be captured instead in a database that includes indicators relevant to an understanding of the impacts of climate change and disaster risks. The database should contain the most recent information on the demographic profile of the target area such as population and density, population growth rate, migration rate, age groups, and the locations of the most socially vulnerable populations. The economic information in the database should include details of the major economic activities of the city and its surrounding areas, including income groups, the location and nature of significant economic activities, employment information, and vulnerabilities of the various economic activities to the impacts of climate change and disaster risks. The socioeconomic database is prepared as a list, while the spatial variation of different indicators used in the database is depicted in the maps.

Target Area Hazard Profile Map

The target area hazard profile map records historical and current hazards identified by the LRAP team through community consultations (checklist 10). The hazard map is annotated to include hazard priorities listed in their order of importance and a disaster history of the city. It may be possible for communities in different parts of the city to assign a different priority to a particular hazard.

Identifying hazards for the target area hazard profile map requires a consensus by the LRAP team as to what are the potential and relative impacts on the city of each hazard in terms of effects on structures, community facilities, infrastructure, and industrial and commercial activities, and the extent of losses. The impact of climate change should be considered based on projections from local studies if available, or from extrapolation of regional/global studies. The local government ideally should enter into a partnership with a local technical support entity, university, or institute to work together to develop the predictions and projections for future climate change impacts.

A history of disasters, especially those that have occurred over the last 50 years as well as major earlier disasters whose records are available, should be prepared to demonstrate and promote the utility of a written record. The disaster history indicates areas affected by floods (including high water marks

Box 4.4 Spatial Analysis of Vulnerabilities Leads to Identification of Target Areas in Ningbo

Ningbo, China, prepared a series of maps based on which a list of priority vulnerabilities was identified. The initial baseline maps showed that Ningbo is located in the middle of China's coast, south of the Yangtze River Delta. The city has six districts, three county-level cities, and two counties, covering an area of 9,817 square kilometers and containing approximately 5.7 million people. The socioeconomic maps identified Ningbo's strategic assets, including its port and diverse industries. The hazard profile maps identified a range of hazards to which the city is susceptible. Seven key climatic parameters are described in the LRAP:

- **Temperature** is expected to continue to rise, and by 2050 could increase by 2.3°C. The inland areas will face even higher temperature increases.
- Though the forecast predicts no significant change in total precipitation, the duration of **rainfall** in an individual event is likely to decrease, leading to higher rainfall intensity.
- **Drought** will fluctuate but follow an upward trend. Cixi to the east is susceptible to more droughts.
- Increasing **heat waves** are forecasted in the city.
- **Flooding** occurs more in Ninghai in the southwest and the urban area in the city center; this is expected to intensify.
- **Typhoon** risk (30-year return period) is expected to increase by 48 percent by 2030 for all assets; for the infrastructure sector, it is expected to increase by 125 percent.
- The city is experiencing an annual sea level rise of 3.3 millimeters. The sea level around the Yangtze River Delta north of Ningbo will rise by 16–34 centimeters by 2030 and by 10–80 centimeters by 2050. Low-lying areas in the east, including Cixi and urban areas, will be vulnerable.

Based on flood risk assessments, it was concluded that floods and waterlogs are among the priority hazards to be taken into consideration.

Three target areas were selected, representing very different socioeconomic characteristics, topography, population, and hazards. Identification of the target areas allowed the LRAP team to take a closer look at the lower government levels and efforts made regarding climate change and disaster risk management.

- The Three River City District is the city's historic-political center. It is very densely populated, and its infrastructure is at capacity and aging. There is a weak overall governance system to manage the infrastructure and address climate change.
- The Port represents the economic powerhouse of Ningbo. Its emergency plans are limited to tropical cyclones; climate change is not incorporated into its plans or decision making.
- The Daqi Township has model, rural area, emergency plans. However, its continuing socioeconomic development may strain its emergency plans. It has not included climate change impacts or natural disaster risks into its socioeconomic policies.

The Three River District and Port areas were selected as target areas because they have experienced frequent and intense past disasters and are threatened by climate change through the increasing intensity and frequency of floods and sea level rising. Despite having different socioeconomic profiles (in terms of active economic sectors, demography, infrastructure, and density), they are vibrant and fast-growing areas. Thus, Criteria 1, 2, and 3 (as listed in the text) were invoked in the selection of the target areas.

Subsequent target area analysis showed which buildings, infrastructure, and economic activities may be at risk in a 50-year scenario; policy recommendations have been formulated accordingly.

Checklist 10 Considerations in Compiling Target Area Hazard Profile Map

- ☑ Is there an existing hazard map? Is it current?
- ☑ Does the working group understand its responsibilities in preparing the map, and are any clarifications required?
- ☑ Did the working group collect enough information on predictions and projections for future climate change impacts?
- ☑ Are manufactured and natural hazards identified, prioritized, and recorded on the map?
- ☑ Are the vulnerabilities of existing infrastructure, natural areas, historic urban areas, and existing settlements recorded on the map?
- ☑ Have public health issues been identified and mapped?
- ☑ Has a disaster history of the city been created and/or updated and discussed?
- ☑ Has the draft hazard map been reviewed and finalized?
- ☑ Have digital copies been made for use in preparation of the LRAP?
- ☑ Have updated maps been distributed to schools and community groups?

or inundation depths), earthquakes, landslides, fires, typhoons, and tsunamis, among others, and documents the frequency of each type of disaster. The disaster history information should be compiled in list form; affected areas should be shown on the map.

The target area hazard profile map should include historic data (possibly up to 50 years) on floods, storm surges, typhoons, sand and dust storms, earthquakes, and landslides. These should be graphically represented on the map to indicate the areas affected and the level of exposure (depth of floods, magnitude of earthquake, etc.) for both an average event and an extreme event (i.e., the occurrence with the worst effects) for each hazard. Supporting annotation should be provided for each hazard. For instance, the annotation for flood hazard may include frequency charts, depth, and inundation duration.

The target area hazard profile map can be developed using the following step-by-step process:

1. Discuss with the working group that the purpose of its effort is to create/update a hazard map that will document and describe potential hazards and disaster impact areas. Explain that this effort is the starting point for the preparation of the LRAP and initiatives to reduce vulnerabilities. Indicate marginal land on which development should not occur, natural reserve areas that are natural defense areas from extreme events, and existing settlements that are in vulnerable areas.

2. Review/create a hazard map with the working group as to what updates and additional information needs are required. Identify new vulnerable areas and changes that have occurred in the land use and development of the target area that has put settlements at risk.

3. Create and/or update a disaster history of the target area indicating dates, types and impacts of disasters (number of persons affected, areas affected, economic impact of the disaster), and their locations.

4. Identify and annotate boundary changes, land resources and natural areas that need conservation, historic urban areas, and marginal land not suitable for development.

5. Discuss and record existing infrastructure vulnerabilities, especially regarding water; sewerage, should it exist; sanitation; public health and other civic investments in city services; and natural reserves and other environmental amenities.

6. Prepare copies of the draft updated map for review with the team, receive its comments, and finalize the draft, preparing additional digital copies for use in the city's information base and the LRAP.

As discussed earlier in the context of the citywide maps, the lack of any of the above-recommended data and analysis should not be allowed to delay the process of creating draft maps. Some cities will have more data available at the target area/ward level than will others; similarly, some will have more capacity for projections and analysis of data. This should not be a constraining factor in the spatial analysis exercise, as these maps and other inputs into the LRAP can be updated as new information becomes available. The LRAP is very much a city's internal planning document to be owned, updated, and mainstreamed into ongoing initiatives by the city at its discretion.

4.3.2 Compile Target Area Future Growth Map

The target area future growth map is based on an appreciation of the importance of addressing the sustainable growth of the city as part of the LRAP process. An extension of a city's master plan map, it is periodically prepared to control and direct development in the city. While the master plan map identifies planned areas of growth and future land use, the future growth map holistically integrates the master plan map contents with additional information based on urban growth trends and hazard projections.

The target area future growth map should identify any projected changes to administrative boundaries, land use, location and densities of economic activity and population, and hazards. Projections (up to the next 50 years) on water level rise, temperature rise, precipitation, floods, storm surges, typhoons, sand and dust storms, earthquakes, landslides, and coastal erosions, if applicable, are graphically represented on the map for both an average event and an extreme event (i.e., the occurrence with the worst effects). Supporting annota-

Checklist 11 Information to Include in Target Area Future Growth Map

- ☑ Existing trends in terms of city expansion and internal transformation: rural-urban migration, peripheral areas of the city being settled, changes in land costs in different parts of the city, industrial relocation, etc.
- ☑ New investments: capital projects the city has identified, planned, and prioritized, especially those that will cause urban expansion (a bridge or highway linking upmarkets, etc.) and those proposed in the city master plan; potential adjustments in the transport, energy, and water (utilities) systems; potential impact of climate change and disasters on the investments
- ☑ Retrofits and enhancements: planned improvements in the existing built environment

tions should include climate change scenarios, available national and local climate impact projections, and natural hazard profile maps.

Understanding how communities should grow is important to climate-resilient city development. Resilient communities need to understand and regulate the growth of their built environment to control sprawl, regulate construction, and create and enforce natural and green zones from encroachment. At the same time, it is also important to recognize that growth is not always planned and that certain organic elements of expansion cannot be fully regulated, as this allows realistic second-best protection measures to be put in place. The facilities and hazard infrastructure that would address identified hazards, such as flood protection, escape routes, raised walkways, canals, improved and more resilient local construction, retrofit programs, and landscape restoration, among others, should be discussed and identified in the future growth map (checklist 11).

The LRAP must take the future growth of a city into account; this means that land resources must be identified as well as the need for capacity to deliver basic infrastructure and services to a growing city population. Land is a particularly important aspect of resilient growth: safe areas need to be identified and marginal land avoided.

4.4 STEP 7. Identify Specific Vulnerabilities

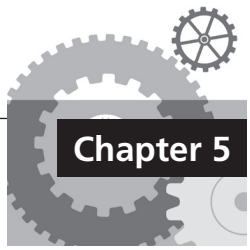
All the target area maps produced should be overlaid to provide a comprehensive lens into each target area's existing and potential future vulnerabilities. This graphical representation should help in the identification of subareas, specific infrastructures, and buildings that are most at risk. The analysis can be facilitated by a one-day workshop by the LRAP team to assess the information and identify particular vulnerabilities based on the target area maps and the socioeconomic and hazard data. Identification of specific vulnerabilities in the target areas should include the following:

- **Specific assets at risk**—for example, a core government administrative building, an emergency response shelter, a key hospital, a school, a shrimp processing facility
- **Specific infrastructure at risk**—for example, a new bridge being built, a main port, a water processing plant, key highways that provide access to the city, the dike system
- **Specific populations at risk**—for example, an informal settlement on marginal land, a concentration of poor households and households with children
- **Specific areas at risk**—for example, a fishing village, a handicrafts village, a garment district, a central business district.

A consolidated list should be drawn up based on the results of the entire spatial mapping exercise and their related discussions. The list of vulnerabilities at the target area level could include structural soundness of important bridges in the target area, developing an evacuation route, increasing public awareness of new health risks, and the need to build local flood defenses. The list should indicate citywide issues relevant to the target area, as well as issues specific to each target area. When drawing up this list, it is important not to lose sight of those citywide vulnerabilities—such as early warning systems, institutional capacity, building codes, and so on—that may not lend themselves to easy identification through spatial analysis.

Notes

1. There are different downscaling methods, each with its own limitations. Nested dynamic models are based on physical laws but are computationally very demanding and tend to preserve the biases from the global climate model used. Statistical downscaling is easier to apply but accuracy is limited by availability of observations and is based on some tenuous assumptions.
2. Suggested formats for producing hardcopy versions of the maps are 8½x11 or A4 paper format for promotion purposes; 24x36 or A2 paper format or larger as a reference for planning larger maps; 24x36 or A2 transparent or tracing paper or larger sheets to overlay and serve as a reference.



Stocktaking and Needs Assessment

This chapter outlines the process of compiling an inventory of national and local government plans, focusing on the institutions responsible for the specific assets, areas, and populations most at risk (built on the exercises described in chapter 4). The inventory will identify in a single place the different national and local government—as well as community, donor, and private sector—policies, plans, and ongoing programs related to disaster risk management and climate change adaptation.

STOCKTAKING AND NEEDS ASSESSMENT
8. Perform institutional mapping
9. Inventory other partners
10. Assess gaps

Compilation of the inventory will be followed by an assessment of gaps in the requirements for increasing resilience based on vulnerabilities identified through technical analysis, with existing and pipeline plans identified through the inventory. The objective of the analysis should be to validate existing approaches; determine potential conflicts among various initiatives; and identify gaps and overlaps in policies, programs, financial resources, and technical capacities of responsible agencies.

This gaps assessment exercise is an important step before specific risk mitigation and climate adaptation measures can be identified for the action plan. The gaps identified will provide the basis for developing a set of potential measures that could either be built into ongoing and planned operations or for which new plans need to be developed (and, for these, help identify the appropriate implementing agency). These would be considered among the priority measures to be designed and included in the action plan.

It will also be of interest to identify plans that are being undertaken under the framework for risk mitigation but that do not, in fact, have any clear rationale based on the technical analysis undertaken (previous chapter)—such as raised walkways proposed in an area without a substantial risk of flooding. These resources could then be diverted to other priority measures identified in the action plan.

5.1 STEP 8. Perform Institutional Mapping

Based on the mapping exercises and spatial analysis described in chapter 4, a list of **systemic** vulnerabilities (e.g., citywide drainage network, land use, building controls, early warning systems, evacuation routes, school safety), as well as of **specific** vulnerabilities (e.g., a particular building, road/bridge, slum settlement, or industrial area within one of the target areas), is compiled by the LRAP team. This list is the starting point for this step. For each item on the list, institutions with jurisdiction over the priority vulnerability identified should be noted. In several instances, multiple institutions may be responsible for specific aspects of a particular vulnerability.

In terms of government institutions, this could include national, provincial, city, or commune-level responsibilities. For instance, issues related to school safety may involve the national ministry of construction, the city-level department of flood and storm control and the department of planning and investment, and the provincial government. It is therefore necessary to identify the specific nature of each vulnerability and map it against the respective institution(s).

An example of this process for citywide vulnerabilities identified in Dong Hoi, Vietnam, is presented in table 5.1 (a blank institutional mapping template is included as template 2 at the end of this workbook). The most critical aspects should be highlighted. In the case of school safety, for instance, the critical structural issue may be construction standards or the level of maintenance of school buildings after their construction; the critical nonstructural issue may be the absence of school disaster management plans or safety drills. The LRAP team should go through this process for each of the priority vulnerabilities identified earlier. A similar process should be carried out for the list of vulnerabilities at the target area level as well.

This process of institutional mapping provides a starting point for identifying the agencies from which to solicit information about their ongoing pro-

Table 5.1 Institutional Mapping: Example from Dong Hoi

Vulnerability	Nature of vulnerability	Institution	Institution type
School safety	Maintenance of school buildings	Department of Education	City government Provincial government
	Construction standards	Ministry of Construction	National government
	Construction of new school buildings	Department of Education	City government Provincial government
	School disaster management plans	Department of Education Youth Union	City government Provincial government NGO
	Planning location of new schools	Department of Education Department of Construction	Provincial government City government

Source: Authors.

grams and future plans. Without undertaking this process, key institutions that could be involved in reducing certain aspects of vulnerability may be overlooked. In approaching these agencies, the primary focus should be on identifying whether they have ongoing or planned programs that directly or indirectly tackle the identified vulnerability on the list.

The secondary focus should be on identifying other plans that these agencies may have in place under the general rubric of disaster risk reduction or climate change adaptation that may not be in direct response to the priority risks. To create an inventory of government plans, the LRAP team should identify existing as well as planned projects that could reduce the identified vulnerabilities as well as other projects with a risk reduction element.

The institutional mapping will provide an agenda in terms of which institutions to visit and what kinds of questions to ask about measures that are being implemented or considered for future implementation. The following documents were useful to this inventory exercise in Vietnam:

- National government policies and programs on climate change resilience (e.g., MONRE's NTP-RCC and MARD's National Strategy for Natural Disaster Prevention, Response, and Mitigation to 2020), focusing in particular on how target areas could be affected by those plans and

programs, including any mandates, and the modalities for national-local transfers of resources and capacities to fulfill these mandates

- Local government development vision, strategy, and planning documents, and any specific plans developed to tackle climate change (e.g., in response to the requirements of the NTP-RCC) and/or natural disasters

- Local government regulations relevant to disaster risk reduction (e.g., building codes, drainage standards, land use and no-build zones) and sector policies for sectors prone to the impacts of disasters (e.g., tourism promotion, cultural heritage conservation, water security, housing provision, urban agriculture/fisheries, handicraft villages, garments)

- Local government budget already allocated/committed/available (including information on the proportion of the city budget raised locally, as opposed to through national transfers) to be programmed for relevant investments and measures that can affect resilience of the target areas and assets at risk (e.g., environmental services, waste and water management systems, afforestation programs, road network)

- Other documents (e.g., studies and analyses completed by universities and research institutions, donors, think tanks, international organizations) relevant to socioeconomic development, natural hazard mitigation, poverty assessment, land use, urban planning/drainage, and so on.

In evaluating the program documents, it is important to consider the possible benefit in reducing adverse impacts of climate change and disaster risk management even if the program has been taken up in response to other considerations. Possible adaptation measures in different sectors may include

- **communications—**disaster-resistant communication system used by the government or people (including disaster-resistant public telecommunications systems);

- **public health—**increase in vector surveillance and control, stockpiling of critical medicines for seasonal diseases;

- **water—**water quality control (standards, regulations), water conservation (usage policy, regulations), wastewater recycling (policy, plans, regulations, programs); and

- **infrastructure**—retrofit of existing vulnerable infrastructure, expansion and enhancement of existing infrastructure, new infrastructure.

In addition, some adaptation or other developmental measures may present opportunities for mitigation that may be no-cost, low-cost, or have other overriding benefits. Some possible mitigation measures in different sectors may address any or all of the following:

- **Energy**—plans, regulations, and programs involving energy efficiency, renewable energy, or energy conservation
- **Transport**—energy efficiency, increase of coverage/encouragement of public transport, vehicle emissions
- **Urban sector**—codes and standards, zoning regulations, construction projects, retrofit projects, urban density
- **Urban forestry**—urban roadside greenery, urban parks and recreational areas
- **Environment**—air pollution, water pollution
- **Solid waste**—waste collection and disposal, recycling
- **Water**—needs, sources, investment
- **GHG emissions reduction**—emissions inventory targets.

For additional examples from cities around the world that have engaged in interesting climate adaptation and mitigation practices, see the City Profiles in the *Climate Resilient Cities* primer (Prasad et al. 2009).

The matrix in table 5.2 is designed to support a city's capacity to identify existing measures and policies/regulations designed to address the specific vulnerabilities identified earlier (a blank matrix is provided as template 3). The matrix captures illustrative details to develop the inventory by area of focus—critical infrastructure (schools and hospitals), transport (roads, bridges, ports), water, sanitation, energy, urban forestry, housing, emergency operations, and disaster risk management systems, among others. Table 5.2 aggregates information on relevant plans and programs in Dong Hoi, Vietnam; the matrix in appendix G provides examples of recently completed, ongoing, and proposed programs that contribute to enhancing that city's resilience to climate change impacts and disaster risks. It is important to include information

Table 5.2 Matrix of Government Plans: Example from Dong Hoi

Sector or functional area	Responsible institution	Relevant program	Status
Flood protection	Quang Binh Department of Construction	Embankment of Nhat Le River from segment Dai bridge to Nhat Le bridge: 3 km	Completed (1999–2005)
	City Environmental Sanitation Project Management Unit	Coastal Cities Environmental Sanitation Project	Ongoing (2006–14)
	City Environmental Sanitation Project Management Unit	Embankment for Phong Thuy Channel and Cau Rao River	Ongoing (2007–10)
	Central Government and Quang Binh Department of Transportation	Extension of bridges and sewer system for roads and railway lines to ensure flood drainage	Ongoing (2008–20)

Source: Authors.

on whether the program is funded or just a notional concept—unfunded mandates should continue to be included in the final action plan but should be treated as gaps until they receive funding for implementation.

Based on this broad-level inventory, the LRAP team can collect more detailed information for each of the relevant programs. Information on each existing program or planned measure (whether structural or nonstructural) should be collected using the template presented in table 5.3 (a blank Project Information Sheet is included as template 4; an example of a completed information sheet for an ongoing project in Dong Hoi, Vietnam, is included as appendix H). The information may need to be collected from diverse agencies, or may require further evaluation of project details and discussions with the implementation team. This information helps in documenting the extent to which priority vulnerabilities are addressed through existing or proposed programs.

The information collected includes an assessment of the vulnerabilities addressed by the project. Often, the project may have been planned to address needs other than those of disaster risk mitigation or climate change impacts management. The Project Information Sheet requires compilation of information on social, economic, and governance vulnerabilities that may be addressed through the program. Analysis of these vulnerabilities, and the extent to which these are addressed, provides invaluable information on the effectiveness of these measures with regard to climate change impacts and disaster risks. The

Table 5.3 Project Information Sheet

1. Title of Project:
2. Funding Agency Type (CPC/PPC/central government/donor), Name of Agency, Total Project Cost, and Earmarked Funds:
3. Implementation Agency:
4. Month/Year Starting and Ending:
5. Areas of Implementation (wards/villages): **a. Citywide:** **b. Target Area 1:** **c. Target Area 2:** **d. Other areas:**
6. Project Classification (project may meet multiple classifications): **a. Developmental—Yes/No** **b. Climate Change Mitigation—Yes/No** **c. Climate Change Adaptation—Yes/No** **d. Disaster Risk Management—Yes/No**
7. Types of Vulnerabilities Addressed: **a. Disaster: Preparedness—Yes/No (Extent: High/Medium/Low)** **b. Disaster: Mitigation—Yes/No (Extent: High/Medium/Low)** **c. Disaster: Response—Yes/No (Extent: High/Medium/Low)** **d. Disaster: Prevention—Yes/No (Extent: High/Medium/Low)** **e. Disaster: Awareness & Sensitization—Yes/No (Extent: High/Medium/Low)** **f. Disaster: Other (please specify)—Yes/No (Extent: High/Medium/Low)** **g. Social: Age—Yes/No (Extent: High/Medium/Low)** **h. Social: Gender—Yes/No (Extent: High/Medium/Low)** **i. Social: Education—Yes/No (Extent: High/Medium/Low)** **j. Social: Health—Yes/No (Extent: High/Medium/Low)** **k. Social: Public Health & Sanitation—Yes/No (Extent: High/Medium/Low)** **l. Social: Education, Employability & Training—Yes/No (Extent: High/Medium/Low)** **m. Social: Other (please specify)—Yes/No (Extent: High/Medium/Low)** **n. Economic: Income—Yes/No (Extent: High/Medium/Low)** **o. Economic: Employment—Yes/No (Extent: High/Medium/Low)** **p. Economic: Other (please specify)—Yes/No (Extent: High/Medium/Low)** **q. Governance: Enhancing Delivery Mechanism—Yes/No (Extent: High/Medium/Low)** **r. Governance: Other (please specify)—Yes/No (Extent: High/Medium/Low)** **s. Climate Change: Reducing GHG Emissions—Yes/No (Extent: High/Medium/Low)** **t. Climate Change: Other mitigation—Yes/No (Extent: High/Medium/Low)** **u. Climate Change: Adaptation—Yes/No (Extent: High/Medium/Low)**
8. If the proposed project does not directly tackle, or adequately tackle, the vulnerability, can the project be expanded/modified to include such? If so, how/what would it take, etc.?
9. Short Description of Project Objectives and Details (1 or 2 paragraphs highlighting the main objectives and important details): **a. Project Objectives:** **b. Important Project Details:**

Source: Authors.

information is later used as a basis for evaluating the need to enhance a program or to extend it to other areas of the city.

5.2 STEP 9. Inventory Other Partners

Private, community, and NGO groups often have a role to play in reducing vulnerabilities, although these will primarily be complementary to government measures, rather than sufficient in and of themselves. For instance, issues related to school safety will necessarily involve government agencies but could also involve a youth union, community associations, and even individual households. Identifying these programs sometimes points to gaps in government programs that are being filled by nongovernmental actors. In some cases, this can establish the need for government to prioritize certain issue areas. In other cases, the complementary activities are not filling a vacuum left by unserved government mandates, but are providing supporting services, or the government may not have the funds to undertake these obligations. In such instances, it is still useful to map activities by partner agencies operating in the city to ensure that funds are being well spent and activities are properly coordinated (checklist 12). For instance, it is not uncommon for multiple donors to be working on very similar research projects or technical assistance. Mapping these initiatives could identify areas of duplication as well as gaps that could be better managed by coordinating the various initiatives.

Checklist 12 Inventorying Existing and Planned Measures

- ☑ Have the national-level programs that influence resilience to climate change and disaster risks and are relevant to the city been included in the inventory?
- ☑ Have the provincial- and local-level programs that influence resilience to climate change and disaster risks been included in the inventory?
- ☑ Have donor programs related to climate change and disaster risks been included in the inventory?
- ☑ Have private sector programs that influence resilience to climate change and disaster risks been included in the inventory?
- ☑ Have community group, civic organization, and volunteer group programs that influence resilience to climate change and disaster risks been included in the inventory?
- ☑ Are documents from international organizations, national government, provincial government, and local government describing their vision, strategies, or plans for evaluating climate change impacts and disaster risks included?
- ☑ Have the possible adaptation, climate change mitigation, and disaster risk management options been considered for compilation of the inventory of measures?

The overall inventory will provide the LRAP team with a list of plans and projects and respective scopes and objectives that will be evaluated against the results of the mapping exercise to verify whether those plans and programs are adequate for addressing climate change impacts and disaster management in the most vulnerable areas identified through the technical anal-

ysis. It will be possible to understand where the gaps are and become the focus for identifying options for resilience.

5.3 STEP 10. Assess Gaps

After mapping government organizations and stakeholders and inventorying relevant plans and policies at the national and local levels, the LRAP team undertakes a gaps assessment. The gaps assessment is conducted at three levels:

- **Technical**—to evaluate the need for augmenting existing measures or defining additional measures to address priority vulnerabilities
- **Institutional**—to determine the mandate and capacity of relevant agencies to frame, implement, and monitor the requisite activities
- **Financial**—to ensure the availability of resources to be able to adequately finance the necessary structural and nonstructural measures and institutional capacity enhancements.

5.3.1 Assess Technical Adequacy

This substep uses the information from the technical analysis described in chapter 4 and the inventory of government plans to assess the technical adequacy of these plans in addressing the priority vulnerabilities. The identification of a gap based on this analysis recognizes that the existing initiative does not adequately address the priority vulnerability. Sometimes, an ongoing or planned project may not have adequately considered its ability to address climate change impacts and disaster risks; its scope can be enhanced to make it more effective. In other instances, the project may not be able to fully address the priority vulnerability because of an inherent limitation due to the nature of the activity, and supplemental activities may need to be formulated.

The following is a suggested procedure for reviewing the technical aspects of each program, plan, and project to identify these gaps:

1. Evaluate the technical parameters and assumptions used for planning each program (e.g., whether the plan has considered all components that need to be strengthened or enhanced such as specific hazards, their level, etc.).

2. Evaluate the procedures and methodologies used to design the programs (e.g., has the program used the most appropriate technical method; have community input and consultation been sought, etc.).

3. Evaluate the expected outcomes and benefits of each program and the issues that the program addresses and gaps that may exist.

4. Evaluate the time frame for implementing each program.

5. Evaluate whether each program is a "no-regrets" endeavor (i.e., one that is beneficial regardless of climate change considerations and will improve resilience).

6. Identify whether modifications to each program are needed and can be undertaken, or whether supplemental activities are required.

Checklist 13 Options to Plug Gaps in Ongoing or Planned Measures

- ☑ Have the technical aspects of an ongoing or planned measure been evaluated to determine its adequacy?
- ☑ Have the various possible natural hazards and climate change impacts relevant to the city as identified through technical analysis been included during the evaluation of technical aspects of the measure?
- ☑ Have the gaps in technical aspects of the ongoing or planned measure been evaluated to determine strategies and importance to plug the gap?

Possible options for overcoming identified gaps are summarized in checklist 13. There can be several technical options for plugging gaps—identifying and choosing among alternatives, and then prioritizing these actions is discussed in the next chapter.

5.3.2 Assess Institutional Capacity

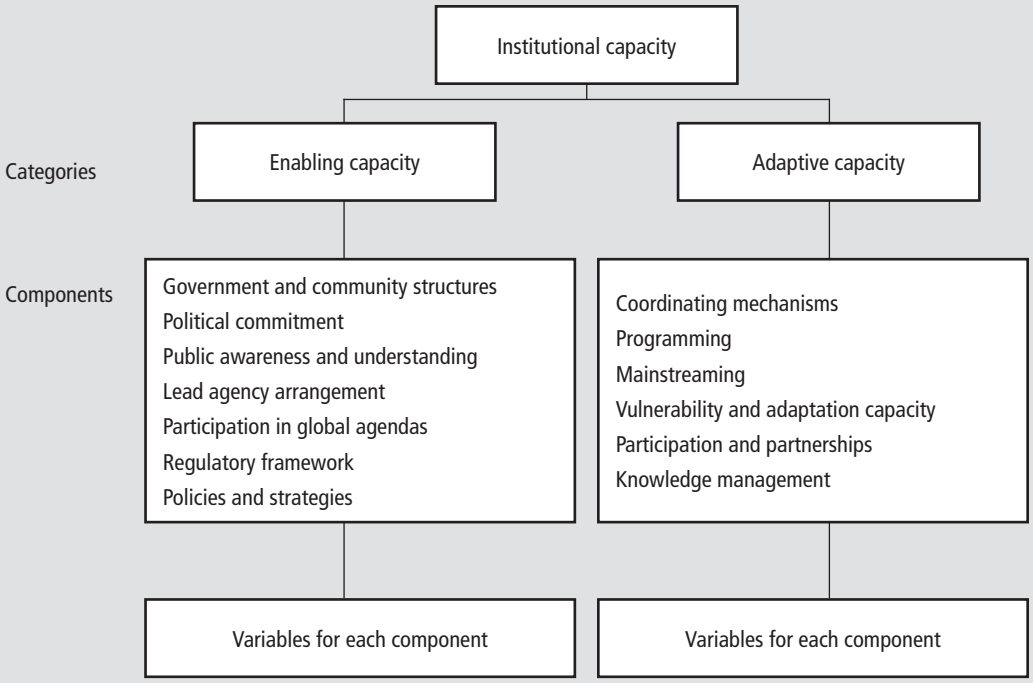
The technical gaps assessment only provides a partial picture of the activities needed in the action plan that will be developed. A major bottleneck often lies in the inability of city governments to identify and conceptualize activities, implement them, monitor progress and make adjustments where needed, and derive lessons for future activities. While the technical experts who are part of the LRAP team can provide support on an as-needed basis, the city government departments must build the capacity to plan and manage the set of activities identified to reduce vulnerabilities. This institutional capacity assessment will identify areas for strengthening that must become part of the LRAP. Moreover, it will allow the LRAP team to make a decision among competing measures to address each vulnerability based on its technical complexity vis-à-vis current capacities of implementing agencies as well as of the LRAP team to oversee its implementation.

Box 5.1 An Approach to Institutional Capacity Assessment

The institutional capacity assessment presented here focuses on two categories and respective groups of interrelated components:

- **Institutional enabling capacity**—ability of institutions to initiate and support the planning, implementation, and strengthening of climate change adaptation and disaster risk management actions. This can also be referred to as the minimal capacity needed in the country to plan, initiate, and coordinate climate change vulnerability and disaster risk assessment and work.
- **Institutional adaptive capacity**—ability of institutions to effectively integrate, coordinate broad stakeholder involvement, and scale up climate change and disaster risk management work in the country and/or city.

The two categories and various components of institutional capacity are presented below.



Source: Adapted from Wickham, Kinch, and Lal 2009.

The team should assess the city's institutional capacity to tackle climate change and disaster risks. Box 5.1 discusses enabling and adaptive capacities; these need to be closely interconnected to ensure effective planning, implementation, and monitoring of vulnerability and adaptation actions.

The institutional capacity assessment can be undertaken at the level of the LRAP team—or the department that has been designated to coordinate implementation of the action plan—or at the level of individual implementing agencies for each of the actions. In carrying out the assessment, the following parameters should be included:

- **Political commitment.** Do the national- and city-level political agendas support climate adaptation and disaster risk management? Is there a need to more clearly articulate this commitment?
- **Legal and regulatory framework.** Does the team have the mandate to plan, monitor, and enforce decisions? Is the lead agency in the LRAP team a "heavyweight," in terms of making things happen, enforcing changes or sequencing decisions, and imposing penalties if actions are not taken?
- **Coordinating arrangements.** Does the LRAP team membership provide links to the implementing agencies and technical partners at a sufficiently high level to enable coordination? Do these links need to be formalized in some way?
- **Technical capacity.** Do the members of the LRAP team have sufficient technical capacity in undertaking the development and monitoring of the LRAP? Can specific areas for capacity building be identified?
- **Awareness raising.** Does the team have the skills and mandate to be able to convey the importance of the agenda within each of their respective line ministries and mainstream disaster risk reduction into sectoral policies? Can they communicate effectively to the public at large regarding their achievements?

5.3.3 Assess Financial Resources

Even if sufficient technical and institutional capacities exist, actions will not be undertaken if they are not adequately resourced. While ongoing programs in the inventory built above will have funds attached to them, the funds for modifying them to include supplementary measures for resilience may not be available. Similarly, new initiatives may not get funded until the new budget cycle.

In some cities where a coordinating disaster office exists, there may be unallocated funds that can be used for priority measures. In other instances, where duplication of activities are found through the inventory process, a case could be made for reallocation of funds. (Note that this may be easier within a single line ministry or department, as reallocation between departments might be politically difficult.) In still other instances, the city may have a reserve fund based on its ability to generate revenues locally or through the markets; this fund could be tapped for the unfunded activities. In addition, national funds may be available specifically for cities that can demonstrate results on their climate and disaster risk reduction agendas—e.g., for implementing the NTP-RCC.

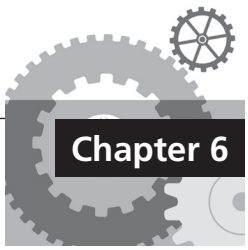
Funding for overseeing implementation of the set of activities in the LRAP will require separate resources as well, and this can either be funded through the above options or from donor funds or other international grants.

It is clear that a sustained funding effort will be required if the LRAP process is to continue as a living document that can be continually refined as actions are undertaken and new vulnerabilities emerge.

Checklist 14 summarizes the key items in the institutional and financial needs assessments.

Checklist 14 Institutional and Financial Needs Assessment

- ☑ Has the institutional mechanism for the implementation of the ongoing or planned measure been evaluated to determine its adequacy?
- ☑ Does the review include both the institutional mechanism for implementation of the program as well as its execution and monitoring?
- ☑ Have the gaps in the institutional mechanism for the implementation of the ongoing or planned measure been evaluated to determine strategies to plug the gap?
- ☑ Have the financial resources for the implementation of the ongoing or planned measure been evaluated to determine their adequacy, and has a strategy to plug these gaps been identified?
- ☑ Is there an evaluation plan in place to follow up and extract lessons learned?



Option Identification and Program Prioritization

The identification of risks due to climate change and natural hazards is used to compile the consolidated list of vulnerabilities in a city as described in chapter 4. The ongoing and proposed programs are analyzed to assess their ability to address the vulnerabilities identified, as described in chapter 5. The gaps in ongoing and proposed programs to adequately address the risks due to climate change and natural hazards can be assessed to determine the areas of priority for new programs or extensions of ongoing programs. This chapter describes the procedure for identifying options and establishing priorities for new programs and for expanding the scope of ongoing programs in order to enhance the city's resilience to climate change impacts and disaster risks.

OPTION IDENTIFICATION AND PROGRAM PRIORITIZATION
11. Identify possible adaptation options
12. Evaluate alternatives
13. Establish priorities
14. Draft detailed plans for priorities

The city may have several ongoing programs dealing with disaster risk management, urban development, social development, health care, and so on, that contribute to adaptation measures and help develop the city's resilience. The gaps assessments (conducted in chapter 5) evaluate the programs shortlisted by the LRAP team to identify the priority vulnerabilities that are not adequately addressed by these programs. The gaps assessment also recognizes that all gaps do not result in the same adverse consequences to the city's population, culture, or economy.

The identification of options and priorities following the gaps assessment are based on an estimation of the consequences of the gaps, the relative importance of various adverse consequences, and the available capacity or institutional mechanism to address the vulnerability. The identification of options and priorities to address the gaps through suitable measures should be carried out at the local level in the target areas. The LRAP team should also consider the important programs (both at the city and local levels) being implemented outside the target areas, to carry out a city-level gaps assessment for major vulnerabilities.

6.1 STEP 11. Identify Possible Adaptation Options

Gaps in the city's programs to address priority vulnerabilities that are identified through spatial analysis and analysis of the inventory of ongoing measures need to be addressed by developing new measures or enhancing ongoing measures. The new measures, or the enhancement of ongoing measures, should be based on a holistic evaluation of options to address the gaps. These possible adaptation measures do not always need to be based on new infrastructure development alone, and can be broadly classified in the following five categories (UNISDR 2009). The LRAP team should consider possible disaster risk management and adaptation measures in various categories to address the priority vulnerabilities so that the most appropriate can be determined (box 6.1).

- **Preparedness**—by developing the knowledge and capacity to effectively anticipate, respond to, and recover from the impacts of likely, imminent, or current hazard events or conditions
- **Mitigation of hazard impacts**—by lessening the severity of its occurrence or the severity of impact in any future occurrence of the hazard
- **Response**—by developing the capacity to provide emergency services and public assistance during or immediately after a disaster
- **Prevention**—by preventing an adverse impact of a hazard from occurring in the future
- **Awareness and sensitization**—by increasing public awareness and education on the risks of different natural hazards and climate change impacts to enable people to prepare for them.

Box 6.1 Some Reference Guides on Disaster Risk Reduction and Climate Change Adaptation Measures

There are several manuals and guidebooks available to help policy makers identify appropriate disaster risk reduction and climate change adaptation measures. Rather than repeat the material they contain here, some useful references follow:

- *Handbook on Building Urban Resilience into Urban Investments* (forthcoming) www.worldbank.org
- *Guide to Climate Change Adaptation in Cities* (2011) www.worldbank.org
- *Climate Risks and Adaptation in Asian Coastal Megacities, A Synthesis Report* (2010) http://siteresources.worldbank.org/EASTASIAPACIFICEXT/Resources/226300-1287600424406/coastal_megacities_fullreport.pdf
- *Safer Homes, Stronger Communities: A Handbook for Reconstructing After Natural Disasters* (2010) http://www.housingreconstruction.org/housing/
- *Climate Resilient Cities: A Primer on Reducing Vulnerabilities to Disasters* (2009) www.worldbank.org/eap/climatecities
- *Urban and Megacities Disaster Risk Reduction: Manual of Sound Practices* (2007) http://www.emi-megacities.org/upload/3cd_2007_MOSP_TR0702.pdf
- *Climate Proofing: A Risk Based Approach to Adaptation* (2004) http://www.adb.org/Documents/Reports/Climate-Proofing/climate-proofing.pdf
- *Building Safer Cities: The Future of Disaster Risk* (2003) http://www.unisdr.org/files/638_8681.pdf

Examples of prevention include improving dikes and embankments to prevent river flooding in the cities and strengthening coastal stretches to prevent erosion and seawater ingress. The mitigation programs can consider those intended to reduce the severity of occurrence, such as improvement in solid waste collection to reduce the incidence of vector-borne diseases; or those intended to reduce the severity of impact of a hazard, such as improvement in a drainage system to reduce the extent and severity of flooding.

Most disaster risk management and climate change adaptation programs can also be beneficial to other sectors such as urban development, social development, and public health, among others. Development of the disaster risk management programs should consider these additional advantages and provide suitable capacity or linkages to adequately address them. Programs to address climate change mitigation—for example, the reduction of GHG emissions—should be included where feasible. Several examples of these programs were described in chapter 5 and include urban greenery programs such as the provision of green-belt on road medians, replacement of conventional street

lights with fuel-efficient ones, and the use of energy-rated electrical appliances.

Possible options for measures to address urban flooding, for example, can include the following:

- Improvement of existing drainage system
- Construction of new drains in areas without existing drains
- Construction of pumps or gates for faster evacuation of drainage system
- Interlinking of drainage systems in different watersheds to improve overall drainage system capacity
- Regular cleaning and maintenance of drains
- Public awareness to prevent accumulation of solid waste in drainage systems
- Improvement in electric supply and telecommunications systems to improve their reliability under submergence
- Establishment of effective forecast and monitoring systems for urban flooding
- Establishment of a public warning system to forecast warnings to people and businesses in flood-prone areas
- Improvement and control of vectors to reduce incidences of post-flooding water-borne diseases
- Improvement of the water supply system to reduce contamination with flood water and consequent water-borne diseases
- Construction of holding or retention ponds to reduce flow rates in drains
- Establishment of rainwater harvesting system in buildings to reduce flow rates in drains.

While the possible programs (such as those described above for urban flooding) are identified to address each gap through a wide-ranging consultative process, each program needs to be hosted in ministries and departments of the government or with the stakeholders in order to facilitate effective implementation. It is suggested that for each possible adaptation or mitigation

measure identified by the LRAP team, the identity of the hosting organization and other details be compiled as per the matrix in table 6.1 (template 5 at the end of this workbook contains a blank version of this matrix). All gaps identified in the gaps assessment should be addressed through proposed programs and included in the matrix.

The significance of the gap is a key consideration in prioritization and should be established by the LRAP team by considering the likely consequences to the city if the gap remains unaddressed. Those gaps that result in severe adverse consequences to a large number of people, the economy, or the culture should be rated high; while gaps that have a negligible impact to the people, economy, or culture should be rated low. If gaps result in extreme human suffering or human fatalities, they should be rated with high criticality, even if they affect a relatively low number of people. If gaps have moderate consequences, or the adverse consequences are limited to a very small number of people, their criticality should be rated as medium.

The program priority (the last column in the matrix) should not be identified at this stage; rather, this is determined during the next step when the identified measures are further evaluated.

The matrix of proposed programs helps to ensure that the LRAP team has considered all gaps identified during earlier evaluations. It also enables the team to consider several possible alternatives to address a particular gap. Evaluation of the criticality of the gap will enable the team to prioritize the identified programs.

Table 6.1 Matrix of Proposed Programs Based on Gap Analysis

Gap being addressed	Criticality of gap (H/M/L)	Program title	Hosting organization	Program priority (H/M/L)

Source: Authors.

6.2 STEP 12. Evaluate Alternatives

The matrix of proposed programs may include several possible options to address a specific gap. Each of these possible measures may improve resilience to a certain extent, and each has its own advantages and limitations. Where several alternatives (options) exist to tackle a single vulnerability, an economic assessment of the impacts of each alternative (social costs and benefits) should be developed to provide a better understanding of the relative merits of each alternative and to inform decision makers as to which alternative is more likely to increase social welfare most. Other factors and criteria (including financial feasibility, political and technical complexities, as well as distributional/equity issues) should also be considered in the context of assessing alternatives. The outcome of this process should be a ranking of alternatives from most to least preferred. The LRAP team will then make the decision about which measure to be prioritized as described in the next step.

6.3 STEP 13. Establish Priorities

Once specific measures have been identified, these too will need to be prioritized, as only some programs can be taken up for initial funding and implementation. The proposed programs need to be prioritized by the steering committee so that the higher-priority programs are detailed before considering the lower-priority programs. Prioritization could be based on a number of criteria including the outcome of the cost-benefit analysis, distributional (equity) issues, the complexity of the project, the time required for implementation, institutional capacity, cultural and social feasibility, alignment of the proposed program with other developmental priorities, and so on.

The priorities should be established through consultations with a broad range of stakeholders in the city in addition to government organizations at the national, provincial, and local levels. In general, proposed programs that meet other developmental priorities should be ranked higher. Extensions of ongoing programs or measures similar to those already implemented in the city represent programs where institutional capacity to implement already exists in the city. Such programs will typically be faster to initiate after funds commitment; they too should typically be accorded a higher priority among various alternatives to address a particular gap.

It is suggested that the project priority be specified in broad terms such as high, medium, or low rather than attempting to establish a numeric order of

priority. This approach will enable the steering committee to choose among projects from the high priority set for further consideration based on policy imperatives.

Appendix I presents a matrix that was used by the LRAP team in Hanoi to determine the priority of a set of suggested adaptation measures (a blank version of the matrix is included as template 6). Those priorities had been ranked as high, medium, or low by a number of participants. The LRAP team developed a set of basic calculations to consolidate all participant evaluations and then defined the priority actions for Hanoi at the city level and at the target area level.

A set of possible measures and actions was provided during the group discussion in Hanoi. The adaptation measures provided were selected after

- conducting a first gap analysis between vulnerabilities and current policies and programs in place to address these,
- collecting recommendations in several meetings at the city and ward levels from local authorities, and
- consulting available documents.

The LRAP team completed the prioritization table at a workshop, which included an assessment of the following:

- The proposed measure and its location
- The responsible implementing institution
- The technical and political complexity of the measure, its cost and benefits, and its estimated duration
- The type of measure (infrastructure, capacity building, etc.) and whether it was an extension of an ongoing program.

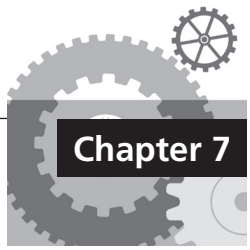
Before agreeing on the final priority-ordered list of measures, it is important to consult with all the stakeholders who will be affected and with the agencies/departments that will be in charge of the specific measures. Using the example of the neighborhood in a flood zone, the list of options can be presented to community leaders or even to the entire neighborhood in a series of open forums. Even if members of the community do not have the final say in the decision-making process, allowing them to express their opinions gives them a sense of involvement and a stake in making sure plans are carried out.

The selected coordinating agency should also have a say about the measure explicitly with regard to its ability to address it.

6.4 STEP 14. Draft Detailed Plans for Priorities

The details of each high-priority program should be compiled using a standardized information template; a completed example is shown in appendix J, and a blank version is included as template 7. This information may need to be compiled from several agencies. Each priority measure should be sufficiently detailed to serve as a project proposal and an input into the overall LRAP implementation plan. Note, however, that this compilation is a first approximation and does not substitute for a more detailed feasibility and design study.

The information template should include a description of the activity and identification of the implementation agency or agencies for the activity, based on previous experience, capability, and legal authority to handle similar measures. It should also include cost estimates (ranges are fine) derived from similar projects done in the recent past either in this or another city. If none of the above information is available, the LRAP team can use benchmarks from sources such as the World Bank, the donor community, and the private sector. A timeline also should be included. The remainder of the template contains a description of the activity, including areas of implementation, vulnerability addressed, project classification, capacity building or training requirements for implementation, and a list of objectives and deliverables.



Plan Creation and Implementation

Planning for local resilience requires four core inputs, as the previous chapters have delineated: (1) sensitization, which includes a high-level vulnerability assessment; (2) technical (spatial) analysis, which involves the development of maps at the city scale to identify hotspots (target areas) and an overlay of detailed maps for each of these hotspots to identify specific assets and populations at risk, resulting in a city vulnerability list; (3) a gaps and needs assessment, which includes an inventory of planned capital investments and regulatory/policy changes to identify any gaps in addressing identified vulnerabilities; and (4) identification of resilience measures and a multi-stakeholder priority-setting process that results in a series of detailed project plans.

7.1 Creating the LRAP

The final task in the process is the collation of all this information into a strategic plan for action—the LRAP. This set of information, graphic representations, and priority definitions is included in the LRAP final document, which summarizes the whole process, showing the core inputs developed and the main outcomes in terms of specific priority needs and suggested resilience measures in the short, medium, and long term; and detailing activities and project investments, with estimated costs, timelines, and responsible actors/agencies. Box 7.1 presents the table of contents of the Can Tho LRAP as an example of the final product. Checklist 15 presents a recap of the process

Box 7.1 LRAP Table of Contents: An Example from Can Tho

undertaken to formulate the LRAP and the questions the LRAP should address. The LRAP actions should be mainstreamed into local and national plans, budget processes, sector strategies, and implementation. Actions for resilience need to be integrated into planning activities as a way to protect lives, property, assets, and the local economy. The LRAP is therefore intended as an organizing framework and not a parallel planning exercise. The identified set of actions will be included in the LRAP as a coherent and consolidated document that will be fed into the regular planning process of the city.

The process of creating an LRAP enables a city government to identify its most important vulnerabilities and establish priorities for specific programs to make the city and its residents safer. However, the LRAP is not self-implementing; the actual work that results from the plan will happen only if the city maintains a focus on the priorities and has a strategy for ensuring that the necessary programs are put in place on a timely basis. This chapter lays out suggestions for some of the important steps to convert the LRAP from a paper document into actions on the ground.

7.2 Developing an Implementation Strategy

An implementation strategy is a necessary tool for planning, executing, implementing, and monitoring any ordered set of activities. To be effective, the

Checklist 15 Creating the Final LRAP

Description of the target areas, which are a selection of the most vulnerable areas in the city that were identified through the vulnerability assessment and stakeholder consultation

- ☑ Which are the most vulnerable areas? Why?
- ☑ Which among those most vulnerable areas are the target areas and why?

Outcomes of the mapping exercise in terms of details about future vulnerabilities and assets/populations exposed in the target areas

- ☑ Which are the most relevant outcomes of the application of the annotated maps to the target areas?
- ☑ What is known better from overlying the city baseline map, the socioeconomic map, the hazard profile map, and the future growth map in the target areas?
- ☑ Where are the gaps, if any?

Review of existing, ongoing, and future plans, programs, and projects

- ☑ Which are the most relevant climate change/disaster risk management projects and actions already launched or programmed in the target areas?
- ☑ Are they affecting the most important vulnerabilities in the specific target areas or just addressing climate impact concerns?
- ☑ Are those projects and actions responding to specific identified needs? Are they preventing specific risks?
- ☑ Is there a comprehensive strategy for adaptation to climate change impacts and for disaster risk management at the city level? What equipment/investments/resources/training/budget are required to apply the strategy?
- ☑ Where are the gaps, if any?

List of priority actions among the possible options, with a description of associated cost/investment, timeline, resources, and possible funding sources

- ☑ How should priority actions be defined in the target areas? Is priority definition determined by the capacity of the specific action to reduce vulnerability/risk (effectiveness), by consistency with national programs (political will), by time horizon (timeline), by funding and finance availability (finance), etc.?
- ☑ Have the actions been sorted by timeline (short-, medium-, and long-term measures)?
- ☑ Has all requisite information been provided for each action (range of cost, resources needed, and list of possible funding sources and funding entities/agencies, as well as financial products that may facilitate implementation)?

strategy depends on several key political decisions. These decisions begin with a choice of the city's strategic priorities for future development and urban planning, regardless of climate change and disaster considerations. Next are such important matters as the scope of an overall budget and the amount of money available for each project. These are important issues that should be addressed when defining the LRAP implementation process.

The implementation strategy serves as an instrument of coordination and provides the direction and transparency needed to foster implementation as well as stakeholder participation and consensus-based decision making. The strategy outlines in specific detail how the LRAP will be implemented, who will work on which priority action, and in what order each action will be accomplished.

The strategy has several elements. It starts with the priority actions already selected and described in the LRAP and defines a plan for coordinating their implementation (**coordination**). It identifies lead responsible entities for the overall plan and for each project, that is, the specific departments of the city's people's committee (**responsibilities**). It proposes the sequence of actions on the basis of resources, both human and financial, plus a timeline (**sequencing**). Related to this is the availability of financing and a strategy to mobilize additional funds as needed (**budget**). It also provides a list of performance indicators to monitor progress of a specific measure in addressing the vulnerabilities, and suggests techniques for building this information into fine-tuning the specific measure as well as the overall program (**monitoring and evaluation**). And of course it should include a stakeholder engagement and communications strategy (**communication**).

7.2.1 Facilitating Coordination

When priorities among several adaptation actions have been selected, and a description and characterization of each selected measure has been developed, the LRAP implementation strategy will provide details on how to order, coordinate, and execute each action. One agency should develop the implementation strategy and oversee its progress. The LRAP coordinating agency will clearly formulate the rationale guiding the LRAP work plan and will link it to the city's existing overall vision. This agency will also develop the work plan and supervise its application. The steering committee from the LRAP team is the natural coordinating entity. If city officials agree, the steering committee could continue its work—perhaps with the same members or with

some new members—to maintain continuity and serve as a coordinating and supervisory body for LRAP work plan implementation.

7.2.2 Establishing Responsibilities

The LRAP should indicate the responsible agency or group of agencies, detailing their specific roles in the implementation of each selected action. Those agencies will be held accountable for implementation of the actions for which they are responsible.

The implementation strategy should include incentives aligned with performance. It is important to make the benefits of participation, and/or the penalties for noncompliance, clear. "Soft" measures may include peer influence, social validation, or aligning a high-level political champion (or even a celebrity) to lend support to the campaign. More concrete measures may include the following:

- **A national mandate**—for instance, in Vietnam, links to requirements under the NTP-RCC or the National Strategy for Natural Disaster Prevention, Response, and Mitigation to 2020
- **A city-level mandate**—for instance, formalizing the LRAP into a government document or implementing regulations that need to be complied with
- **Resourcing**—providing adequate funding for tasks and additional funding for subsequent activities or phases on a competitive basis to those agencies that are able to demonstrate progress
- **Consistency**—repeatedly enforcing the message that implementation is necessary and that results are being monitored
- **Results**—publicly displaying where progress has been made (this will also gain support for more difficult measures) and where action has fallen behind schedule or expectations
- **Reward**—the city people's committee/mayor's office may decide to establish an annual award for the department that best complied with the LRAP.

7.2.3 Effective Sequencing of Actions

The implementation strategy should provide a sequence for priority actions, depending on human and financial resources needed for implementation and technical effectiveness. Human resources, such as city officials, personnel, consultants, and technical experts who will participate in implementation of the priority actions, will be mapped and specific objectives, tasks, and schedules will be assigned. A budget will be associated with each measure.

Even more important is the technical basis for sequencing. Some measures identified must be implemented before others or in conjunction with others. For instance, when increasing the capacity of microdrains in a particular ward, considerations need to be made for appropriate increases in flow intake into larger connecting sewerage systems. When a road is being constructed, sewers should be constructed in tandem to avoid the more costly approach of having to dig up and lay pipes after road construction.

7.2.4 Developing a Budget and Seeking Financing

It goes without saying that an unfunded mandate is rarely implemented. Without adequate funding to undertake the resilience measures outlined in the LRAP, they will not be realized. Representation on the steering committee by high-level policy officials from various city departments ensures their participation in the decision-making process and their endorsement of the contents of the LRAP; however, earmarking budgets against new plans or expanding activities already under way once the budget cycle has begun may not be so straightforward. Once the LRAP has been completed, each department implementing a specific measure will need to go through formal channels to obtain an allocation within its existing budget.

In some cases, this will mean a reallocation from other projects that the **department** is undertaking but that are deemed less important or effective. In other cases, the department of programming and investment may decide that additional funds need to be raised at the **city** level and may explore various means of generating additional local revenue through the existing tax base. In still other cases, the chair of the people's committee/mayor may request additional transfers from the **national government** for LRAP implementation. There may be opportunities for national funds to support the implementation of local action plans in response to country policies and programs (e.g., in Vietnam, MONRE's NTP-RCC, the National Strategy for Natural Disaster Preven-

tion, Response, and Mitigation to 2020, or the Ministry of Construction's urban planning guidelines).

Multilateral development banks as well as bilateral donors are interested in supporting disaster and climate resilience. If a city has a concrete set of prioritized actions framed in the form of an LRAP, with justification provided as to why these activities are needed, donors will see that a fair amount of due diligence has already been done by the city and that there is initiative for implementation. Tapping these sources as well as international adaptation funds should be explored.

The body coordinating implementation of the LRAP will need to keep track of which activities have sufficient funds (and from where) and which need additional funds, and develop a strategy to procure funds for these activities. Transparency in the process—and reporting publicly on funds leveraged and how they have been spent—will be critical to maintaining credibility and sourcing additional funds.

7.2.5 Monitoring and Evaluation

The implementation strategy should include a set of performance indicators to evaluate ex ante and ex post effectiveness of each priority measure in reaching its objectives of enhancing the city's resilience. Specific measurements include the capacity to follow a schedule and to make best use of financial and other resources. The results of performance measurements are then used to improve the overall plan and the measures that are part of it. The system should be designed to provide feedback into improving future iterations of the LRAP.

Project monitoring is an integral part of the project planning process and entails the following steps:[1]

1. Identify the project development objectives.
2. Identify the elements of the project results chain.
3. Select indicators for each outcome, result, output, and input that are measurable and integral to the progress of the project.
4. Specify the frequency of data collection and the level of detail to be collected for each selected indicator.
5. Identify data sources and determine the data collection procedure.
6. Collect baseline data for the indicators determined earlier.

The body coordinating LRAP implementation will need to oversee the status of the various activities—those that have started (and how far along they are) and those that have not yet started (and why). This will help identify problems in start-up so they can be addressed, as well as evaluate ongoing measures.

Project evaluation uses the baseline data collected for the selected indicators for each outcome, result, output, and input. The project evaluation process entails the following:

1. Evaluate the baseline data to assess project progress for each outcome, result, output, and input.
2. Provide analysis regarding the progress both where it is not satisfactory, and its likely causes, and where it is satisfactory.
3. Evaluate the necessity of modifying project objectives, program details, or implementation systems and discuss this with the steering committee for a final decision.

Having a well-designed monitoring and evaluation system is critical to the success of LRAP implementation. It allows early detection of measures that may need fine-tuning and adjustment, and allows learning to be built in to update the LRAP.

7.2.6 Communications and Stakeholder Engagement

Building in a strategic communication plan for LRAP implementation is essential to the progress and success of the initiative. It will help build support for activities by increasing awareness, inducing behavioral change where required, and enabling stakeholders to be involved and to raise their concerns in a two-way communication stream. In essence, communications involves various interest groups in the implementation process to ensure buy-in and thus increase the chances of success and sustainability.

The communications strategy for the LRAP should include the following key elements:

- **Overarching goal.** The rationale for the activities in the LRAP should be clearly formulated and linked to the city's overall vision (see chapter 3). "Branding" the LRAP campaign can make it easier for stakeholders to recognize the various actions undertaken as part of an overall program and to develop support for that program.

- **Stakeholder mapping.** Identifying the stakeholders and their level of buy-in for various activities in the LRAP is a first step toward customizing strategies to engage them. Champions for implementation are as important to recognize as groups that may potentially block implementation.
- **Products and channels.** Developing specific products to engage interest groups, but also convey progress of implementation and provide forums for input, will help deliver results. The program's credibility relies on demonstrating short-term achievements and progress in longer-term initiatives. This also helps build momentum.

Box 7.2 can be used as a guide in designing a communications strategy (template 8).

Critical support for the actions in the LRAP will already have been built through the process of evaluating adaptation options and establishing priorities (chapter 6). In the implementation phase, mapping stakeholders may uncover additional alliances that need to be built. Stakeholder mapping allows:

Box 7.2 Communications Strategy

1. **Review.** How have we been communicating in the past?
2. **Objectives**. What do we want our communications to achieve? Are our objectives SMART (specific, measurable, attainable, relevant, time-bound)?
3. **Audience.** Who is our audience? What information do they need to act upon our work?
4. **Message.** What is our message? Do we have one message for multiple audiences or multiple messages for multiple audiences?
5. **Basket.** What kinds of communications "products" will best capture and deliver our messages?
6. **Channels.** How will we promote and disseminate our products? What channels will we use?
7. **Resources.** What kind of budget do we have for this? Will this change in the future? What communications hardware and skills do we have?
8. **Timing.** What is our timeline? Would a staged strategy be most appropriate? What special events or opportunities might arise? Does the work of like-minded organizations present possible opportunities?
9. **Brand.** Are all of our communications products "on brand"? How can we ensure that we are broadcasting the right message?
10. **Feedback**. Did our communications influence our audiences? How can we assess whether we used the right tools, were on budget and on time, and had any influence?

Source: IDRC 2008.

- identification of various interest groups,
- segmentation of groups based on their positions,
- preparation of appropriate messages to mobilize support where needed, and
- finding an effective mix of channels to reach audiences.

The first step is to identify the various groups that may be interested in the LRAP overall and in each of the activities included in the LRAP. For a particular measure, these groups may include the following:

- The people's committee department tasked with implementing the measure
- The department that will be responsible for operations and maintenance (this may or may not be the same as the implementing department)
- The funding agency or agencies (this may or may not be the same as the implementing department)
- Other people's committee departments that may be affected by this action
- Communities directly affected by the measure
- Technical institutes or universities that may be conducting relevant research
- Provincial or national government entities with relevant regulations
- Other city governments that may have undertaken similar measures
- International agencies and donors that may have ongoing or pipeline programs that will be affected by the measure.

Box 7.3 provides some guidance on conducting stakeholder analysis.

Within the various groups, there may be some that are more affected than others; similarly, there may be some that are more influential than others. The objective of stakeholder mapping and assessment is to identify different types of interested stakeholders and analyze their position and their relative weight and influence in the decision-making process as well as in the sustainability of the effort. Table 7.1 illustrates the concept of stakeholder mapping; a blank

Box 7.3 Stakeholder Analysis

Segmenting stakeholders and audiences

- Who are the internal and external stakeholders related to the project? Will they be winners or losers? What is their political influence? Do they know they will be losers? What are their issues?
- Who are the potential beneficiaries? Who might be adversely affected?
- What are the relationships among these stakeholders? Power relations?
- How can stakeholders be divided into manageable groups? Does the general trade union federation, for example, have a different view than the specialized unions that represent workers directly affected by the initiative?

Identifying public opinion leaders or allies

- Do the present leaders drive the project demand? If not, who should lead it? Why?
- Who should not be involved in the process? Why?
- Who are the partners or potential partners in the program/project?
- What institutions or NGOs are working in the same sector? Can alliances be built with those potential partners? What are the risks?
- Have supporters and opponents been identified?

Recognizing socially relevant topics

- Regarding the problem that the initiative is trying to resolve, what is its position/priority in people's minds?
- What is the link between the initiative and people's priority concerns?
- Can people identify with and understand the benefits of the initiative related to their concerns?
- Is the development initiative considered among the alternatives that people mention?

Understanding expectations and perceptions

- What are the expectations that the project or reform has generated among stakeholders? Has any opinion or attitudinal research been done? If so, has it been reviewed for implications to the project or to determine additional needs? Have the results been included in the project design?
- What is the opinion about the governmental agency in charge of project implementation? Could this opinion affect the project?
- What activities could obtain public support for agency performance? What are the different scenarios? Do people understand the general benefits and disadvantages of the project? What are their opinions about the process? Is there public support for the project? Is there any quantitative data on this aspect?
- What are the stakeholders' opinions about the political actions involved?
- Is there any other project that, in people's minds, competes with this project? How?
- What are the risks people identify with the project? What do they see as the strengths of the project?

Recognizing reactions to similar experiences

- Is there a past history of similar projects? What do people associate with these?
- What associations (institutions, people, models, etc.) do people make with the current project?
- What aspects are remembered as positive? Why? (Evaluate the arguments.)
- Have experiences with past projects created any sectoral relationships in people's minds?

Source: Adapted from Mitchell and Chaman-Ruiz 2007, p. 24.

Table 7.1 Stakeholder Mapping

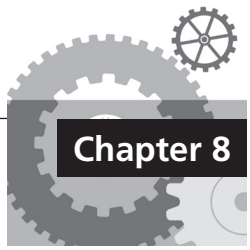
	Unmovable opponent	Opponent	Uncommitted/ uninvolved	Supportive	Extremely supportive
No effort					
Activate					
Reinforce					
Persuade					

Source: Adapted from Herzberg and Wright 2006, p. 96.

template is included as template 9 at the end of this workbook. Use this matrix for each measure undertaken; list the specific stakeholders/groups in each cell so that appropriate communication strategies can be designed.

Note

1. Adapted from World Bank (2007).



Concluding Remarks

8.1 Lessons from the LRAP Experience to Date

The experiences of the three pilot cities in Vietnam— Can Tho, Dong Hoi, and Hanoi—have demonstrated that, to be successful, the LRAP process needs a great deal of support, coordination, and sustained work. The process was subsequently undertaken in Iloilo, the Philippines; Ningbo, China; and Yogyakarta, Indonesia—with each city adapting the LRAP process to fit its own circumstances and needs.

In Vietnam, the impetus for developing LRAPs came from two forces: (1) the need to develop provincial and local strategies to respond to the targets set in the NTP-RCC and the National Strategy for Natural Disaster Prevention, Response, and Mitigation to 2020 and (2) the mandate from the Ministry of Construction for cities to update their master plans. In Iloilo, the process was begun as a result of a devastating typhoon—Typhoon Frank—that hit the area in 2008 and from which recovery efforts were still under way. In Yogyakarta, the devastation caused by the 2005 earthquake was fresh in the city's memory; once it realized the additional risks that climate change could bring to the city—such as droughts, landslides, flooding, and cyclones—the community wanted to be prepared. In Ninbgo, the desire to develop an LRAP was born when the city planning department was made aware of the increasing climate risks facing city: under some scenarios, Ningbo would experience a 10-fold

increase in exposed population and a 120-fold increase in exposed assets, granting Ningbo the top spot on the list of exposure of port cities around the world. In fact, the Organisation for Economic Co-operation and Development ranked Ningbo as one of the most vulnerable port cities in the world, with high socioeconomic assets and population exposure. Ningbo itself has estimated that natural hazards would threaten about 4,600 people and Y 11.23 million ($1.6 million) in assets.

The process by which the LRAP was developed, its contents, and the form it took (in terms of output) also varied across the cities. In Vietnam, the focus was on current hazard risks and, while potential future climate impacts were examined, the list of priorities identified in the LRAPs were not heavily weighted toward reducing climate risks. In Hanoi, the team also wanted to include a couple of items in the LRAP that were purely focused on greening the city, with a link to climate mitigation. In Can Tho, while climate mitigation options were included, they tended to be focused on cobenefits where the action served to both reduce risk as well as reduce carbon. The Dong Hoi LRAP was much more squarely focused on risk reduction. All three cities developed and formally endorsed self-standing LRAP documents, which they planned to subsequently mainstream into other ongoing activities, such as the master plan updates. The process for developing the LRAPs was, by and large, government focused; while stakeholder consultations were held at key junctures of the process, it was mostly guided by technical consultants and discussed with the steering committee.

By contrast, in Yogyakarta, LRAP formulation was very much a bottom-up process. While technical consultants were engaged to undertake the analysis, community groups were involved from the very first in terms of conceptualizing the issues and identifying actions—sometimes so much so that the actions did not immediately follow from the technical analysis, which, in itself, was less sophisticated than in some of the other cities. Many of the actions were also directly aimed at environmental sustainability over and beyond risk reduction measures, as these were priority areas for the community. As a result, the initial priority actions tended to be at a very local (neighborhood or urban ward) scale. Only after several iterations with technical departments within the city administration were attempts made to add a broader perspective and map priority community actions to relevant city development projects. The output was, again, a stand-alone LRAP document with actions that would need to be advocated and retrofitted into the ongoing city development program.

In Ningbo, the process was much more top-down, with a team of experts reporting to the planning department. The LRAP also had a much heavier emphasis on modeling future growth, disaster, and climate scenarios. Even if data and maps were lacking, the technical rigor undertaken in Ningbo was perhaps the strongest, as the city benefited from strong synergies and cooperation between two projects undertaken at the same time (LRAP preparation and application of the Multi-Hazard City Risk Index) and learning from other city experiences. Ningbo was also most focused on climate change. Once again, the final product was a stand-alone LRAP document.

Iloilo was the only city where the final output of the exercise was not an LRAP per se but a "recovery plan" strategically positioned to leverage the fresh memory of the havoc wreaked by Typhoon Frank. However, the process engaged in mirrored what is outlined in this workbook. While the starting point was recovery efforts, the substantive contents of the plan are actually focused on preventive activities, just as with the other LRAPs. It also includes a few activities related to emissions control and heritage conservation. The plan focused quite strongly on identifying areas for institutional capacity building and awareness raising, in addition to identifying capital investments. A driving force for change was the local government of Iloilo City, which witnessed how a severe typhoon undermined decades of development of one of the country's regional economic centers. This perspective was shared by the private sector in Iloilo, which had a vested interest in ensuring that vulnerabilities in the city were reduced for the future prosperity of their businesses. Aside from the plan, Iloilo also produced specific inputs into the zoning ordinance that was being updated as part of a comprehensive land use plan.

While each city customized the LRAP to its own context, all of the cities created multi-departmental steering committees, solicited inputs from a variety of stakeholders, and leveraged relationships with technical universities and experts in framing the analysis. Based on their experiences, the following are some of the important lessons learned thus far.

- **Creating an appetite for change.** City governments and their people are sometimes unaware of their current hazard profile and how it is expected to change in the future; in other cases, there is some level of awareness but so many more pressing issues that hazard risk is often swept under the rug. There can be a range of impetuses for prioritizing hazard risk—most often, unfortunately, it tends to be the aftermath of a recent disaster that creates the demand for preventive action in the

future. While recovery activities are obviously the most immediate concern, it is imperative not to lose opportunities for risk reduction measures as well and to initiate the LRAP process. In other instances, the impetus comes from new research and public information on climate impacts that either generates a demand from the population (in elected democracies) for action or a realization among the city leaders themselves. In other instances, city governments are responding to national government mandates which themselves might be the result of international dialogue. Whatever the impetus, it is important to quickly launch the LRAP process before the momentum dissipates.

- **Institutional and political support.** Because the process of developing plans to confront long-term problems requires time, money, and political capital, it is essential for the process to have unequivocal support from key decision makers and the institutions with the necessary influence to get things done. A plan that lacks the support of key constituencies, either in the government or within the broader community as a whole, likely will never be translated into action or trusted enough to be fed into regular urban planning. Top policy makers should be given adequate information to help them understand why taking action is necessary for the good of the community and for the political institutions they represent. This is why raising awareness of the likely impacts of climate change is so important up front. In all three pilot cities, the vice chairmen clearly expressed a willingness to "own" the process, thus improving the chances for success. Several meetings have been held with chairmen and heads of departments, first to build awareness, then to share results and select the most important measures to enhance resilience in the cities. In Yogyakarta, the initiatives emerged from the strong drive of local community organizations and academics facilitated by a few champions within the city administration. Maintaining the balance between this bottom-up approach and formal bureaucratic and political processes has been an interesting experience.

- **A host department or agency.** Many branches of government should have a role to play in the planning process. However, the process needs a host or champion—an agency or even an individual who advocates for the process and coordinates the work of various departments. The champion must be clearly appointed by the chairman, recognized by the other

departments as the leader, and committed to the job. In some of the pilot cities, the LRAP team faced delays in collecting information and data, could not count on cooperation from specific departments, and did not receive feedback and comments on the analysis and outcomes in a timely and effective manner. Clearer identification of the department in charge of the program and a better definition of roles and responsibilities could have helped in overcoming this impasse. At the start, the role of the city planning office/agency is critical in facilitating the process.

- **Stakeholder consultation.** Consulting early and often with the public and affected communities is likely to ensure ownership of and buy-in to the results of the analysis. People who have been consulted and made to feel that their views count are more likely to take the process seriously than those who feel they have no stake in the outcome. Local stakeholders have been a critical part of the process in the three pilot cities in Vietnam, especially in Can Tho where the program benefited from a consolidated partnership with local organizations and NGOs. Yogyakarta presents an interesting case where the city government became a member of the multi-stakeholder forum. The forum elected thematic leaders and formed groups with a mixed membership of local activists, academics, and city officials.

- **Providing adequate budgets and time for the work.** Developing a realistic and workable LRAP requires work by many people over a period of time; it is not something that can be done by a few people in one or two meetings. If the local government is serious about the process and about getting results, it will devote adequate resources to complete the job. The experiences in Can Tho, Dong Hoi, and Hanoi clearly show that human and financial resources have been the greatest constraint to progress. Lack of capacity, together with lack of time, posed a great challenge for the city officials in charge of collecting information, preparing spatial analyses, and selecting priority actions. Most of the activities have been done by the World Bank team and its consultants, mining the ownership of the project and potentially reducing the capacity of city officials to continue, replicate, and scale up the planning process.

- **Institutional coordination.** City-level departments often have a sound understanding of climate change issues, but they tend to focus only on how climate change could affect their respective activities. A resulting

lack of coordination among government departments has been a key challenge encountered in the three pilot cities and is likely to be an important issue in other cities in Vietnam and elsewhere. Many agencies collect data and produce indicators, maps, and reports; however, those data and representations are not always shared or agreed upon with other line agencies. The LRAP team needs assistance in transforming this knowledge into action at a broader level. In Hanoi, for example, data collection was done by the LRAP team that visited each department and some districts and wards to produce maps at the macro and target area levels. The information and maps collected and assembled were eventually shared with the broader climate change team in several workshops; this certainly contributed to some sort of sharing, but did not necessarily stimulate coordination among different departments. In some instances, the city may find it useful to engage an external facilitator to assist with coordination.

- **Vertical coordination.** National plans and policies often are not supported by budgets and authorities at the local level, which clearly has implications for ownership and action. The need for a formal structure for vertical coordination across government entities (national-provincial-local) is an important lesson. In the case of Yogyakarta, the first LRAP pilot in Indonesia, the initiation, finalization, and exposure of the pilot was used to engage broader policy dialogues led by national-level agencies.

- **Leveraging existing initiatives.** Developing an LRAP should be incorporated into the city's ongoing planning process and seek to meet national requirements. For example, an LRAP should support the city's overall master plan and other national-level policies and programs. In addition, resilience planning by cities will help countries meet obligations imposed under a potential international agreement in the current Copenhagen process. In Ningbo, several initiatives and projects on climate resilience have been launched almost simultaneously: to avoid confusion and duplication of efforts, the teams involved in the LRAP initiative and in the Multi-Hazard City Risk Index worked together, exchanged information and data, and shared outcomes and recommendations. This cooperation has been highly beneficial to the city which was thus provided with a cohesive set of spatial representations, hazard

mapping, climate change and natural hazard scenarios, multi-hazard index, and consistent recommendations for future policies and programs.

- **Balancing the roles of different departments.** Various departments in a government have different views and priorities. In Vietnam, for example, the responsibility of dealing with climate change typically resides in the department of environment, while disaster risk management responsibilities generally reside in the emergency response department. The two departments often do not communicate, thus making coordination difficult. Interdepartmental institutional set-ups or common programs with shared funding can help bridge this divide. It also is important for all relevant departments to have some involvement in the planning process, although key decision makers may need to balance inevitably competing viewpoints.

- **Follow the process.** This workbook lays out a series of steps that have been carefully designed to produce an action plan to make communities and neighborhoods safer. Some communities may wish to carry out these steps in a somewhat different order or depth than is suggested here. However, all of the steps should be taken at some point in the process to ensure that all the necessary work is done.

- **Internalize experiences and lessons learned.** Successful implementation of the LRAP in a city will require overcoming new and unforeseen challenges. It is important for the city to document these lessons and internalize them in its LRAP process. This facilitates an organically developing LRAP that is relevant and addresses the concerns of all stakeholders while meeting the requirements of making the city resilient. The process should be institutionalized into local systems and procedures to ensure continuity, despite changes in political leadership or priorities.

- **Applying workarounds in the absence of data, tools, and capacities.** The LRAP team should understand what is reasonably doable with the amount of information available and what could be added, if anything, through better coordination and sharing and through additional field work, especially at the target area level. The spatial analysis exercise is likely to require the greatest efforts. The pilots have shown that cities have the data required for the preparation of their baseline and future growth maps in a variety of formats. Some cities make extensive use of

GIS software; others use mapping software such as AutoCAD for maintaining their planning maps. In some cases, the requisite information may only be available in hard-copy maps. The spatial analysis should aim to use all available information regardless of the format in which it is available. The overlaying process in which the maps are superimposed to identify the most vulnerable areas can be done manually using transparencies or tracing paper, or electronically by controlling the layers that are seen. Both processes can provide identical results if done carefully, and the choice of process will depend on the format of available maps.

- **Working with real facts.** Using hard data derived from careful study and observation rather than unsupported assumptions can serve as an agent for change. Producing rigorous analysis that leaves little room for debate (or doubt) and that provides visual mapping of natural hazards and climate risks can strengthen the imperative for action. Stakeholder involvement in generating and analyzing the data, and powerful visual representation can help motivate and involve local people more proactively.

- **Engaging technical experts.** A city government should not see climate resilience planning as something it must do entirely on its own. The need for assistance from national and provincial governments might seem obvious, but so, too, is the desirability of obtaining technical, financial, or other kinds of support from research institutions, universities, NGOs, and other organizations. Spreading the work does have costs, particularly in the need for coordination and consultation, but the potential benefits can far outweigh those costs. The Can Tho experience shows that cooperating with local universities, associations, and international NGOs, despite possible delays and additional discussions, helps broaden the consensus on the climate resilience agenda. In Yogyakarta, the pilot project engaged experts from local NGOs and several major universities based in the city. These experts also donated their own time, linked the planned actions to their networks, and continue to advocate for implementation of the relevant actions (such as on long-term climate modeling) through their own work.

- **Getting outside help.** The World Bank and other agencies stand ready to assist various government levels as they work through the planning

process. Outside facilitators can provide valuable perspective (particularly in evaluating proposals in light of international experience) and can carry out such tasks as collecting data, compiling results of surveys, or even working through different viewpoints.

- **Setting the wheels in motion.** Developing the LRAP is a big accomplishment, but it is just the beginning of a process, not the end. In many of the pilot cities, once the LRAP document was completed, the steering committees disbanded and placed the document on the shelf rather than developing an implementation strategy.

8.2 Looking Forward

The creation of a local resilience action plan is not the end of the process of improving a city's climate resilience. Completion of the plan marks the beginning of the next phase: implementation of the various actions that have been established as the highest priorities and inclusion of those actions among traditional urban planning activities. In other words, the plan is not a collection of wishes but a guide for actual change mainstreamed into a city's planning regime.

Remember too that the LRAP is a living document, one that each city should update with additional target areas and/or activities. This updating can take place as the need arises or as additional resources are mobilized.

This workbook's focus is on developing plans for specific target areas—that is, those neighborhoods or sectors of a community that are most vulnerable to the types of natural disasters worsened by climate change. Work done for one target area can be useful in other target areas or even in different cities. For example, a plan to protect a residential neighborhood in a low-lying area can serve as a demonstration project for similar neighborhoods.

Finally, this workbook is intended to help other cities develop their own LRAPs so they, too, can have more secure futures. The pilot cities have led the way. Other communities can benefit from the lessons those cities have learned that are in the updated process for developing LRAPs outlined in this workbook.

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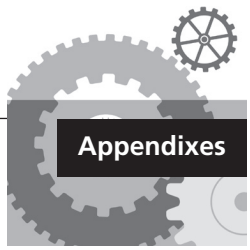


Appendixes

A. Characteristics of the Pilot Cities

Hanoi, Dong Hoi, and Can Tho served as pilot cities for the application of the local resilience action plan methodology (figure A.1). It is through these pilots that the framework and methodology for developing LRAPs was fine-tuned as presented in this workbook. These cities were chosen as pilots because they represent a broad range of city characteristics in Vietnam in terms of geography, population size, economic base, administrative structure, and natural hazards (table A.1). Each of three cities represents one or more types of "hotspots," localities particularly subject to natural disasters that are made worse by climate change.

Figure A.1 Location of Pilot Cities

Source: World Bank.

As the national capital and the country's second largest city, Hanoi has a unique economic and political importance in Vietnam. Hanoi is inland but regularly experiences severe flooding from the Red River; it faces the prospect of even more severe floods due to the consequences of climate change and environmental degradation.

Dong Hoi is a relatively small coastal city and the capital of the Quang Binh province. The central coastal region has historically been one of the most disaster-prone in Vietnam, threatened repeatedly by floods and typhoons. Climate change will make these disasters more frequent and severe, posing particular danger to the majority of people in the province whose livelihoods depend on agriculture and aquaculture.

Can Tho, in the south, is another city with important links to agriculture and aquaculture because of its location on the banks of the Hau River, in the center of the Mekong River Delta. The Hau experiences severe fluctuations in tidal levels and may face even more dramatic changes if the sea level rises because of climate change. Major floods, caused by typhoons and tropical storms, routinely inundate large portions of the city and surrounding countryside.

Table A.1 Characteristics of Pilot Cities for the Climate-Resilient Cities Program in Vietnam

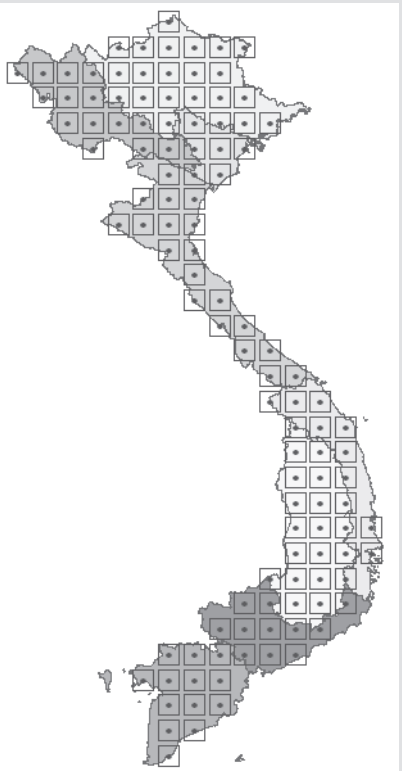
City	Administrative position	Population	Economy	Location/ geography	Hazard	Technical capacity/data availability
Can Tho	City	Medium: 1.2 million	Aquaculture; construction; port	Southern, Mekong Delta	High tide (H) Storm surge (H) Extreme precipitation (H) Sea level rise (M) Landslide (M) Windstorm (M)	High-medium
Dong Hoi	Provincial capital	Small: 104,000	Beach; tourism; fisheries; port	Central, coastal, along Nhat Le River	Sea level rise (H) Coastal erosion (H) Flash flood (H) River flood (H) Landslide (M) Tsunami (L) Extreme temperatures (L) Drought (L)	Low
Hanoi	National capital	Large: 3.4 million	Industry; financial services; tourism	Northern, inland, along Red River	River flood (H) Flash flood (H) Typhoon (H) Windstorm (H) Extreme precipitation (M) Landslide (M) Extreme temperatures (M) Drought (L) Earthquake (L)	Medium

Source: Authors.

Each of the pilot cities is projected to experience climate change impacts in the future. As part of its Economics of Adaptation Study, the World Bank undertook a country case study of Vietnam. A climate projection database for Vietnam was assembled based on 14 general circulation models under the A2 scenario of the Intergovernmental Panel on Climate Change's (IPCC's) Special Report on Emissions Scenarios (see appendix E for more information); this was downscaled for 38 grid cells across the country (figure A.2). The database uses 2000 as the base year, and backcasts the monthly time series to 1971 and forecasts projections to 2070.

Using a mean of the 14 models for each of the locations corresponding to the three pilot cities, two variables were examined in the LRAP exercise:

Figure A.2 Vietnam: Agro-Ecological Zones by Grid Cells



Source: EACC Vietnam Technical Note 2009.

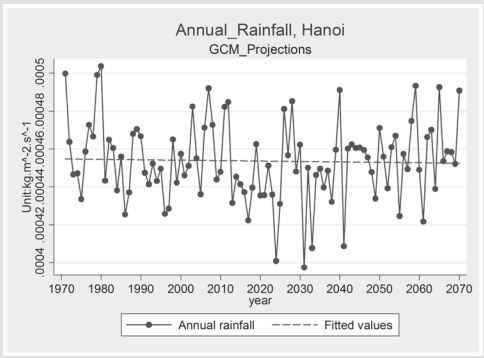
Note: Grid cells are 0.5° latitude by longitude.

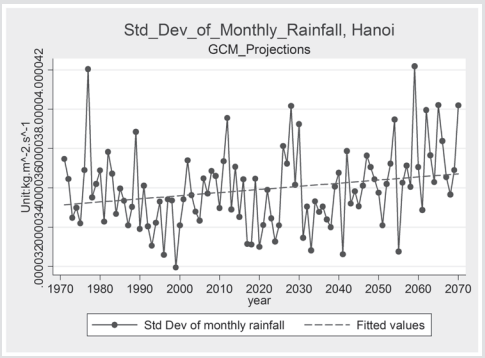
- Total annual precipitation and the standard deviation of monthly precipitation
- Annual mean of daily maximum surface temperature and the standard deviation of monthly temperatures.

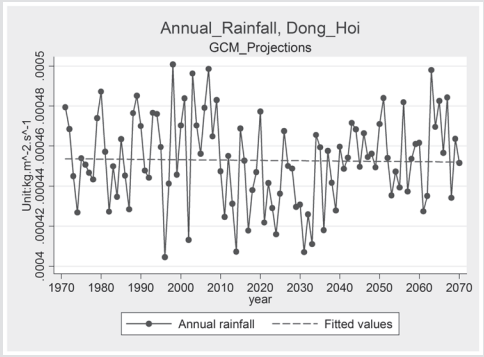
The results, presented in figures A.3 and A.4, show that total annual precipitation in Hanoi and Dong Hoi will remain fairly constant in 2070 and that Can Tho will experience a slight increase. More significant is the variability of rainfall—changes to the monthly rainfall within each year are expected to increase over time. This will of course have implications for agricultural yields as well as for urban flooding.

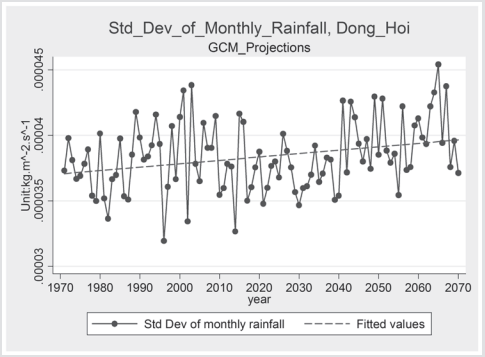
Larger increases are expected for temperature. All of the cities are likely to experience a 2.5-degree increase in temperature in 2070 as compared to 1970, or about a 1.5-degree increase from today. Heat stress in urban areas and the resultant requirement for greater cooling, water consumption, disease epidemics, and infrastructure design will all need to be planned for.

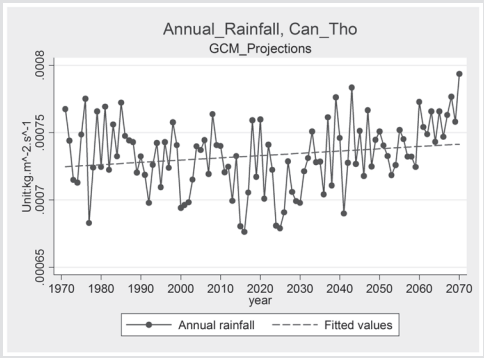
Figure A.3 Changes in Precipitation in Three Pilot Cities

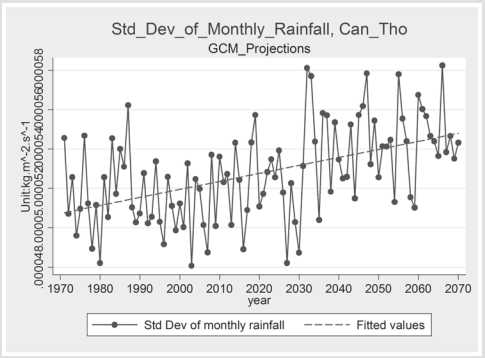






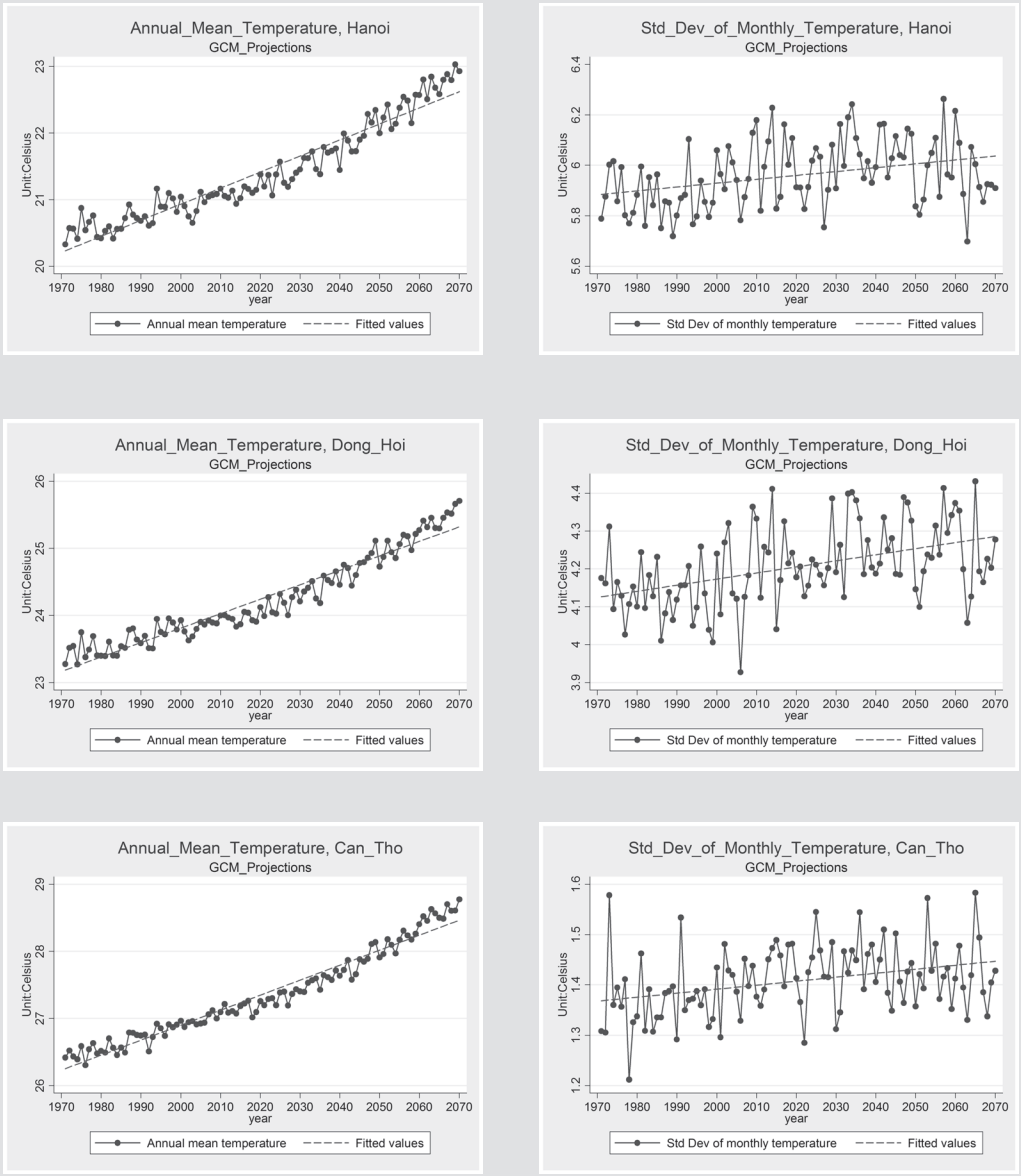






Source: Authors.

Figure A.4 Changes in Temperature in Three Pilot Cities



Source: Authors.

B. Hanoi City Typology and Risk Characterization (Hotspot Assessment) Matrix

City Description and Size Characteristics

A. City description	
1. City location	
a. In a coastal area? (Y or N)	N
b. On or near mountain area? (Y or N)	Y
c. On inland plain? (Y or N)	Y
d. On inland plateau? (Y or N)	N
e. Near to or on a river(s)? (Y or N)	Y
f. Near earthquake fault lines? (Y or N)	Y
B. Size characteristics of city	
1. Resident population (VH, H, M, or L)	H
VH = Greater than 5 million H = 2 million–5 million M = 0.5 million–2 million L = Less than 0.5 million	
2. Population growth during last 10 years (H, M, or L)	M
H = Greater than 10% M = Between 2%–10% L = Less than 2%	
3. Floating population (VH, H, M, or L)	M
VH = Greater than 30% of resident population H = Between 20%–30% of resident population M = Between 10%–20% of resident population L = Less than 10% of resident population	
4. Area in square kilometers (km^2)	3,400
5. Maximum population density (day or night) (H, M, or L)	M
H = Greater than 2,000 persons per km^2 M = Between 1,000–2,000 persons per km^2 L = Less than 1,000 persons per km^2	

Governance Structure, City Management, and Financial Resources

C. Governance structure as related to disaster risk management	
1. Appointed head of government? (Y or N)	
a. Term of assignment (Years)	
2. Elected head of government (Y or N)	Y
a. Term of elected officials (Years)	5
3. Local government office structure: does it have…	
a. Disaster risk management department? (Y or N)	Y
b. Environment, sustainability, or climate change department? (Y or N)	Y
c. Are (a) and (b) in the same department? (Y or N)	N
4. Other government office structure (state, national)[a]: does it have…	
a. Disaster risk management department? (Y or N)	Y
b. Environment, sustainability, or climate change department? (Y or N)	Y
c. Are (a) and (b) in the same department? (Y or N)	N
D. City management on climate change and disaster risk management	
1. Responsibilities clearly specified? (Y or N)	N
2. Responsibility for climate change management established? (Y or N)	N
3. Responsibility for disaster risk management established? (Y or N)	Y
4. Authority to contract for services? (Y or N)	N
E. Financial resources	
1. Total budget	
2. From local taxes and levies (% of total)	
3. From state/national government grants and devolutions (%)	
4. From domestic market (%)	
5. From international market (%))	
6. From external or multilateral lending agencies (%)	

a. District level.

Built Environment

F. Built environment	
1. Does the city have urban growth master plans? (Y or N)	Y
2. Does the city have urban development and land-use plans? (Y or N)	Y
a. Population in authorized development (% of total)	
b. Population in informal or temporary settlements (% of total)	
c. Population density of informal settlements (H, M, or L)	
H = Population of informal settlements >20% of total M = Population of informal settlements <20% but >10% of total L = Population of informal settlements <10% of total	
d. Population in old tenements and historical development (% of total or H, M, or L using ratings in 2c)	
3. Does the city have building codes? (Y or N)	Y
a. What is level of compliance? (% compliant buildings)	
4. Observed vulnerability of buildings in past natural disasters (extent of disruption of building functionality)	
a. Informal buildings (H, M, or L)	H
H = >15% of informal buildings highly vulnerable M = 5%–15% of informal buildings highly vulnerable L = <5% of informal buildings highly vulnerable	
b. Historic buildings (H, M, or L)	L
c. New and formal developments (H, M, or L)	H
H = >5% of new and formally developed buildings highly vulnerable M = 1%–5% of new and formally developed buildings highly vulnerable L = <1% of new and formally developed buildings highly vulnerable	

Political and Economic Impacts

G. Political impact of disasters	
1. Is the city a national/provincial capital or where a large number of decision makers live? (Y or N)	Y
2. Is impact of disaster in the city likely to influence political activity in areas far away from affected regions? (Y or N)	Y
H. Economic impact of disasters	
1. Is the city a major center of economic activity in regional or national context? (Y or N)	Y
2. Do the following sectors have major activity in the city?	
a. Industrial sector? (Y or N)	Y
b. Services sector? (Y or N)	Y
c. Financial sector? (Y or N)	Y
d. Tourism and hospitality sectors? (Y or N)	Y
e. Agriculture, aquaculture, and rural sectors? (Y or N)	

Hazards and Disaster Response System

I. Threat of natural hazards	
1. Earthquake? (Y or N)	Y
2. Windstorm? (Y or N)	Y
3. River flood? (Y or N)	Y
4. Flash rainwater flood or extreme precipitation? (Y or N)	Y
5. Tsunami? (Y or N)	N
6. Drought? (Y or N)	Y
7. Volcano? (Y or N)	N
8. Landslide? (Y or N)	Y
9. Storm surge? (Y or N)	N
10. Extreme temperature? (Y or N)	Y
J. Disaster response system	
1. Does a disaster response system exist in the city? (Y or N)	Y
2. Is the response system comprehensive and equipped for all natural hazards specified? (Y or N)	N
3. Is the disaster response system regularly practiced? (Y or N)	N
4. Is the disaster response system regularly updated? (Y or N)	Y–information; N–equipment

Climate Change Impacts

K. Climate change impacts	
1. Is the impact of climate change on the city known? (Y or N)	Y
2. Are the following sectors vulnerable to the consequences of climate change?	
a. Built environment? (Y or N)	Y
b. Cultural and religious heritage? (Y or N)	Y
c. Local business, industry, and economy? (Y or N)	Y
d. Energy generation and distribution system? (Y or N)	Y
e. Health care facilities? (Y or N)	Y
f. Land use? (Y or N)	Y
g. Transportation system? (Y or N)	Y
h. Parks and recreation areas? (Y or N)	Y
i. Tourism? (Y or N)	Y
j. Agriculture and rural? (Y or N)	N–global
3. Is climate change assessment based on local studies instead of regional/ global models? (Y or N)	
4. Does the city have a climate change strategy (maybe as a component of national policy)? (Y or N)	Y
5. Does the city have climate change programs in place? (Y or N)	N
6. If yes, do the climate change programs consider:	
a. Mitigation? (Y or N)	
b. Adaptation? (Y or N)	
c. Resilience? (Y or N)	

Vulnerability Assessment for Various Consequences of Climate Change in Urban Areas

Sector	Temperature rise	Precipitation change	Sea level rise
Built environment (H, M, or L)	M	M	L
Cultural and religious heritage (H, M, or L)	M	M	L
Local business, industry, and economy (H, M, or L)	M	M	L
Energy generation/distribution system (H, M, or L)	M	M	L
Health care facilities (H, M, or L)	M	M	L
Land use (H, M, or L)	M	M	L
Transportation system (H, M, or L)	M	M	L
Parks and recreation areas (H, M, or L)	M	M	L
Social equity system (H, M, or L)	M	M	L
Water management (H, M, or L)	M	M	L
Tourism (H, M, or L)	M	M	L

Level of Preparedness/Readiness for Various Natural Hazards in Urban Areas

	Sector			
Hazard type	Industrial	Services	Financial	Tourism and hospitality
Earthquake (H, M, or L)	L	L	L	L
Windstorm (H, M, or L)	H	H	H	H
River flood (H, M, or L)	H	H	H	H
Flash rainwater flood or extreme precipitation (H, M, or L)				
Tsunami (H, M, or L)				
Drought (H, M, or L)	L	H	H	H
Volcano (H, M, or L)				
Landslide (H, M, or L)				
Storm surge (H, M, or L)				
Extreme temperature (H, M, or L)	H	H	H	H

C. Can Tho Steering Committee and Working Group

On March 27, 2009, the chairman of the Can Tho City's People's Committee signed Decision 917/QĐ-UBND to establish a Can Tho Steering Committee on Climate Change (SCCC). The committee was set up to implement the memorandum of understanding between the People's Committee of Can Tho and the World Bank.

Committee members are the heads/deputy heads of departments of the Can Tho local government that play key roles in the identification of priorities and the design and implementation of activities to address potential impacts of climate change and disasters that affect Can Tho (table C.1). The SCCC actively participated in a hotspot assessment and has contributed significantly in formulating the LRAP by providing SCCC member time and staff to work with the World Bank team.

The committee has the following responsibilities:

Table C.1 Members of the Can Tho Steering Committee on Climate Change

Name	Position at time of LRAP development	Title in the SCCC
Nguyen Thanh Son	Vice Chairman of Can Tho City's People's Committee	Head
Duong Ba Dien	Director, Department of Natural Resources and Environment	Standing Deputy Head
Pham Van Quynh	Director, Department of Agriculture and Rural Development	Deputy Head
Nguyen Thi Cam Hong	Director, Department of Foreign Affairs	Member
Tran Thanh Can	Vice Director, Department of Planning and Investment	Member
Nguyen Trung Nhan	Vice Director, Department of Science and Technology	Member
Pham Van Nhon	Director, Institute for Architect, Urban and Rural Planning	Member
Nguyen Dong Ha	Vice Chairman of Red Cross	Member
Bui Thi Le Phi	Vice Director, Department of Health	
Vo Thi Hong Anh	Vice Director, Contraction	
Ky Quang Vinh	Director, Can Tho Center for Natural Resource and Environment Monitoring	Secretary

Source: Authors.

- To help Can Tho City's People's Committee in directing the effective implementation of all activities related to Decision 158/QĐ-TTg signed February 2, 2008, to approve national target points in response to climate change
- To formulate priorities and implement plans to respond to climate change impacts of Can Tho, and assign clear responsibility for each SCCC member to organize implementation and monitoring of activities in the target areas
- To collaborate with national, local, and foreign institutions to carry out activities related to climate change and disaster management
- To supervise and effectively implement activities within a reasonable time; make monthly, quarterly, and yearly reports; and conduct ex post reviews and evaluations to extract lessons learned for the next round of activities.

The committee has appointed a group of midlevel government experts and technical specialists to a Climate Change Working Group (CCWG) to work directly with the World Bank Climate Resilient Cities team and other partners to implement program activities. The CCWG is led by Ky Quang Vinh, Director of the Can Tho Center for Natural Resource and Environment Monitoring. The Vice Chairman of the Can Tho People's Committee and Head of the SCCC stated that the CCWG will be the designated entity for the People's Committee to represent and manage climate change activities in Can Tho and engage with national climate change programs as they develop. The composition of the CCWG is as follows:

- **Team leader:** Ky Quang Vinh, Director of Can Tho Center for Natural Resource and Environment Monitoring, Department of Environment and Natural Resources
- **Specialists:**
  - Ho Minh Ha, Head of Land Administration, Department of Environment and Natural Resources
  - Pham Nam Huan, Deputy Head of Environment Division
  - Do Thi Hoa Nam, Office Deputy Manager, Department of Environment and Natural Resources

- Au Quoc Thong, Specialist of Planning Division, Department of Environment and Natural Resources
- Chau Thi Kim Thoa, Specialist of Environment Division, Department of Environment and Natural Resources
- Phan Ho Hai Uyen, Specialist of Environment Division, Department of Environment and Natural Resources
- Vương Thi Lap, Head of Irrigation Division, Department of Agriculture
- Nguyen Thi Kieu, Head of Plant Protection Division, Department of Agriculture
- Le Ngọc Dien, Deputy Head of Aquaproduct Division, Department of Agriculture
- Khong Duc Duyen, Deputy Head of NGO Division, DoFA
- Doan Anh Luan, Head of Medicine Professional Division, Department of Health
- Le Văn Be Tam, Specialist of Economic Division, Department of Programming and Investment
- Pham Hoang Dung, Specialist of SMQ Division, Department of Science and Technology
- Nguyen Thanh Tai, Planning Specialist, Department of Construction
- Du Hai Duong, Deputy Head of Propaganda and Training Division, City's Red Cross
- Le Minh Ton, Specialist, Department of Transportation and Civil Engineering
- Nguyễn Kim Hoàng, Specialist, Department of Transportation and Civil Engineering

- **Secretary:** Nguyen Hong Xuyen, Specialist of Natural Resource and Environment Monitoring

The CCWG will be in charge of the following tasks:

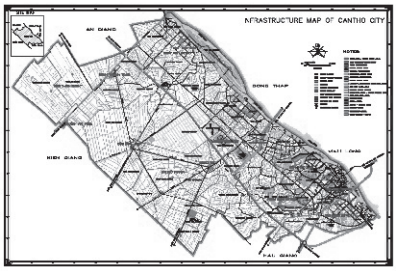
- Generate the baseline macromap and identify target areas at a one-day workshop.
- Collect data/maps and generate the baseline map, socioeconomic map, hazard profile map, and future growth map for each target area.
- Convene a one-day technical working session at which the mapping overlay exercise will be done, target vulnerabilities in each target area will be identified, and institutional actors in charge will be specified.

- Provide plans and information for an inventory of government actions.
- Convene an SCCC meeting to present findings and establish priorities.
- Conduct a stakeholder workshop to evaluate potential actions and vet priorities.
- Circulate the draft LRAP to relevant government officials and departments to provide consolidated feedback in a timely manner.
- Facilitate the SCCC to endorse the LRAP and make it a public document.
- Integrate the results of the LRAP into investment planning, urban planning, and natural disaster mitigation platforms and processes at the city and local levels.

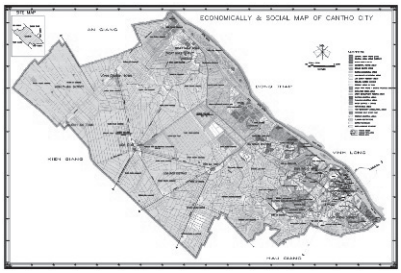
The CCWG members will actively participate in the collection and analysis of information, development and review of outputs, and contribute technical and logistical support to the ongoing development of LRAP activities. The CCWG is authorized to work directly with people's committees at the district and ward/village levels to ensure information is made available and to conduct necessary meetings, workshops, and site visits. The CCWG prepares information and plans to be presented to the SCCC for its review, input, and approval. With the approval of the SCCC, the CCWG can carry out the tasks and initiatives identified. The CCWG staff designated by the Department of Environment and Natural Resources, the Department of Programming and Investment, and the Department of Construction was actively involved in the preparation of the information base and mapping exercise based on information extant in their departments as well as in gathering information for the inventory of ongoing and planned activities and projects. The SCCC chairman is expected to carry out Department of Environment and Natural Resources responsibilities as the lead department for maintaining and updating the LRAP information base, identifying and implementing the next round of priority activities and target areas, and documenting activities.

D. Can Tho Maps

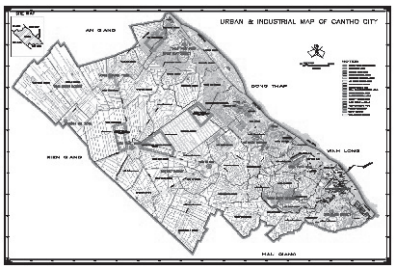
Baseline Map



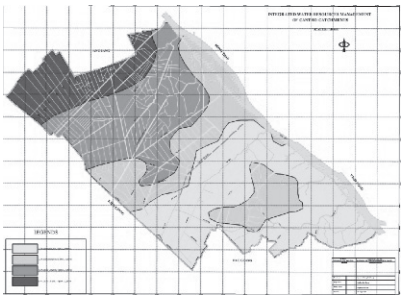
Socioeconomic Map



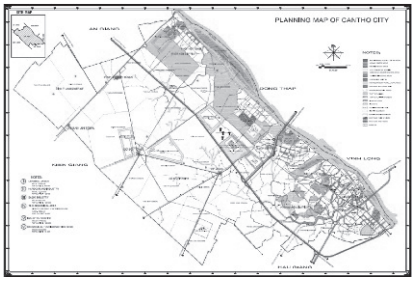
Socioeconomic Map: Urban and Industrial Features



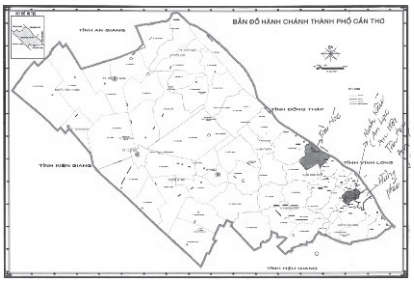
Hazard Profile Map



Future Growth Map



Selection of Target Areas



E. Methodology for Hazard Mapping as Applied in Vietnamese Pilot Cities

Hazard mapping should be based on the observations of past hazards. However, in most Vietnamese cities, this information may not be available at the same level of detail for all areas. Typically, areas of economic or administrative importance have better availability of information and data. Where accurate data are not available, hazard potential mapping can be based on easily, and more or less globally, available input data, such as historic flood data, Shuttle Radar Topography Mission (SRTM) data, geological maps, and so on, at a regional scale. The applied methods are rather straightforward, not very complex, and can be implemented and adapted with affordable efforts under a fairly wide range of environmental conditions. Remote sensing data and their proper use and evaluation are the key to this approach.

However, there are limitations to such an approach, which must be clearly understood by users in order to keep expectations realistic. Table E.1 summarizes the benefits and limitations for a quick review.

Table E.1 Benefits and Limitations of the Applied Approach

Benefits	Limitations
▪ Results achievable at relatively low cost ▪ Input data are widely available (e.g., SRTM, satellite data) ▪ Methods are straightforward and can be adapted with minor effort to new applications ▪ Results can be obtained within relatively short time periods ▪ In the absence of detailed and more analytical methods, this approach constitutes a valuable first evaluation and hotspot mapping method	▪ Only regional ranking of hazard intensities, no absolute (actual scale) intensity figures ▪ Regional-scale analysis, not suited for detailed local investigations ▪ Strong simplification, not very many input factors considered ▪ Empirical approaches in flood mapping rely heavily on representative historical flood maps

Source: Geoville Group.

E.1 Input Data

- **Digital elevation model and derived parameters.** For a large part of the Hanoi study region, a 30 m SRTM digital elevation model (DEM) was used. As it was found that this model has elevation values consistently some 3 m above the 90 m SRTM, and the latter was deemed more correct as compared with Web sources for Hanoi, the 30 m DEM was height-adapted to the 90 m DEM and then embedded in the 90 m DEM.

- **Slope.** Slopes can be calculated by taking the maximum rate of change in value from each cell to its eight neighbors. The maximum change in elevation over the distance between the cell and its neighbors identifies the steepest downhill descent from the cell.

  Conceptually, the calculation fits a plane to the z-values of a 3x3 cell neighborhood around the processing or center cell. The slope value of this plane is calculated using the average maximum technique (Burrough and McDonnell 1998). The direction the plane faces is the aspect for the processing cell. The lower the slope value, the flatter the terrain; the higher the slope value, the steeper the terrain. The output slope raster is provided as degree of slope.

- **Aspect.** The aspect identifies the down-slope direction from each cell to its neighbors. It can be thought of as slope direction or the compass direction a hill faces. Aspect is measured clockwise in degrees from 0, due north, to 360, again due north, coming full circle. The value of each cell in an aspect data set indicates the direction the cell's slope faces. Flat areas having no down-slope direction are given a value of –1. The aspect of the coast was used as a proxy indicator for the direction of the predominant wave action to derive a coastal erosion potential.

- **Geology.** The relevant geological features can be extracted from the geological map of Vietnam, scale 1:500,000, vintage 1988, published by the Geological Survey of Vietnam. This map identifies the most important geological strata and provides a short description thereof. These data were used in the generation of the coastal erosion potential for the area of Dong Hoi.

- **Hydrological features and water bodies.** The hydrological features and permanent water bodies of the cities in Hanoi are available from the

Department of Environment and Natural Resources and the Department of Construction. Hydrological features resemble small streams and canals, which may be of a temporary nature. Permanent water bodies, such as larger rivers and lakes, should be included in the relative flood potential maps of the cities.

- **Historic flood extent.** Historic flood extent data should be collected from various sources, including existing maps from the Internet and satellite imagery (free downloads from the Internet). For the three study areas, different quantities and types of input data were available. These maps and satellite images need to be georeferenced (WGS84, UTM North Zone 48), and the flood extents extracted by means of classification techniques.

E.2 Methodology

E.2.1 Hazard Potential Mapping Scheme

For inland flooding and coastal erosion, the project approach produces a relative ranking of hazard potentials, expressed in the five classes of no/low/moderate/high/very high potentials. To accommodate the different resolutions and accuracies of the input data, the output grids were transformed to 250x250 m cells using the nearest neighborhood method.

For sea level rise, the assumed coastal inundation levels associated with the applied sea level rise scenarios were directly expressed in meters and related to tidal ranges, wave height, and expected sea level rise due to storm surges.

E.2.2 Inland Flooding Potential

The aim of mapping inland flood potential is to provide an overview of the relative flood-proneness within each studied area. That means that each area under investigation is subdivided according to the classification scheme into four flood hazard potential classes plus a "no potential" class. The absolute hazard intensity—that is, flood frequency, level, and duration at a particular site or the flood probability at a certain time—is not derived. However, the relative flood potential classes incorporate a ranking of these hazard intensity parameters and may be described as follows:

- **Very high flood potential (class 5)—**areas most frequently facing flooding, with the highest flood levels and the longest flood duration

- **High flood potential (class 4)—**areas frequently flooded, with high potential flood levels, but with a shorter duration of flooding compared to class 5
- **Moderate flood potential (class 3)—**frequent floods may occur, but flood levels are lower and their duration shorter than at locations with class 4 or 5 under average conditions; in extreme events (e.g., strong rainfall, dike breaks), these areas may also be severely hit, but will drain more quickly than class 4 and 5 areas
- **Low flood potential (class 2)—**areas occasionally flooded, normally with low flood levels and shorter flood durations than class 3, 4, or 5 areas; very heavy floods may also hit these areas significantly, but they will drain more quickly than class 3, 4, and 5 areas.

E.3 Hydraulic Modeling

Hoa et al. (2007) apply a very detailed hydraulic model for their flood level calculations, which include 2,535 flood cells; 13,262 cross sections; and 467 sewers, bridges, and sluices. Embankment elevation data, hourly water level data, and tidal data are used in their complex model, which shows the varying inundation depths based on a row of scenarios, including one typhoon scenario. Given the high degree of reliability of this model according to the cited paper, such a model seems to be an ideal tool to compute flood levels at the local and regional levels under different input scenarios.

In the absence of such modeling capacity, and also for model output validation and detailed temporal/spatial analysis, remote sensing data (optical and especially radar data to overcome the cloud cover) are a valuable tool for mapping flood extents.

Note that hydraulic modeling is a complex and time-consuming process. This procedure produces the most accurate results, and should be an important study to be undertaken in the medium term in case data are not already available. However, due to the complexity and cost, the availability of these results is not essential for the development of the LRAP. The LRAP development process should use all available information, including those of past disasters. The detailing of the priority project proposals identified through the LRAP process may require hydraulic modeling, and may be carried out at this stage.

E.4 Estimating the Impacts of Climate Change

To measure the impacts of climate change, given the high level of uncertainty, it is necessary to assume emissions scenarios and climate change forecasts. The potential impact of climate change may vary greatly depending on the selected scenario for GHG emissions. Those scenarios are projections of the future and are a tool to model climate change impacts, based on assumptions of development pathways (which are a combination of demographic and economic growth, and environmental and technological changes) (World Bank 2010b).

As described in the Intergovernmental Panel on Climate Change's Special Report on Emissions Scenarios (IPCC 2000), four storylines yield four different scenario families—A1, A2, B1, and B2—that have allowed development of 40 different scenarios organized in six groups (IPCC 2007). Each of these scenarios is equally valid, with no probabilities of occurrence assigned. Projections of future climate change are usually derived from global climate models. A global climate model is a mathematical representation of the climate system based on the physical attributes of its components, their relation, and various feedback processes. Various emissions and concentration scenarios (A1, A2, B1, and B2 as discussed above) are used as inputs into climate models to estimate global climate projections.

As World Bank (2010b) notes "there are a number of caveats about the use of climate models." First, there is a set of uncertainties, starting with the emissions scenario chosen, uncertainties in future concentrations and carbon dioxide feedback cycles, uncertainties in the response of the climate, the global climate model used, the downscaling technique utilized, and the manner in which those parameters (e.g., precipitation and temperature increase) that are generated are applied in estimating impacts at the city level. Despite these uncertainties, climate change models do allow global forecasts, and increasingly the downscaling techniques are providing information on the likely scale of various climate impacts at local levels.

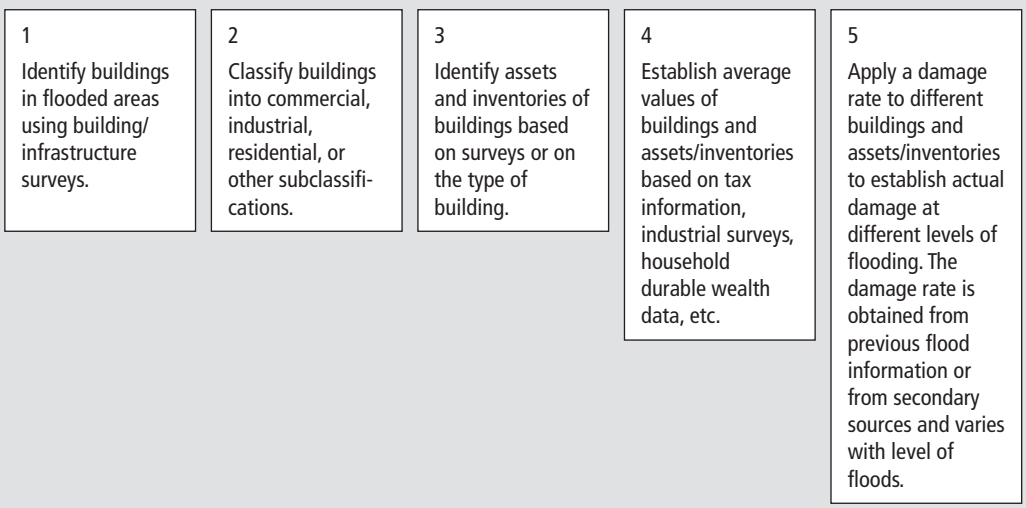
When data and information are not fully available or capabilities and knowledge is not yet sufficient to develop a cutting-edge set of scenarios or downscale existing national ones, some assumptions can be made from a literature review, deriving data from similar geographic locations or regional climate models.

Those scenarios (when available) or assumptions about future climate impacts should then be included into the future growth map, in particular into the future hazard profile map. For example, to estimate the extent of flood risk in the future for a city, hydrometeorological models can be developed. These models are based on a host of historical and city-specific information, such as existing drainage and sewerage systems, soil characteristics, river flow, canals, dams, land subsidence, siltation, existing flood protection infrastructure, and so on (which should already have been included in the city hazard profile map) but also on the projections of rainfalls, sea level rise, and storm surge alone or in conjunction with other storm events, to estimate future flooding under different scenarios.

The hydrological models simulate the movement of water on land after precipitation falls. Those estimates lead to a better vision about the impacts of climate change to the future growth of a city.

A recent study by the World Bank attempted to identify possible damage to which climate change can contribute. Figure E.1 shows a summary of key impacts of floods on existing buildings based on a study developed in Manila and Bangkok (World Bank 2010b).

Figure E.1 Estimation of Damage to Buildings, Assets, and Inventories from Floods



Source: World Bank 2010b.

E.5 Sea Level Rise and Resulting Coastal Inundation Potential

Currently, estimates of the amount of sea level rise in the coming decades vary considerably. Table E.2 shows a recently compiled list of estimations from a World Bank report. While these estimates differ at the submeter scale, the

Table E.2 Estimations of Sea Level Rise

Source	Esttimated increase	Comments
University of East Anglia, UK	Between +32 cm and +64 cm; +45 cm most likely to year 2010. Therefore approximately +25 cm by 2050	Based on 1992 IPCC assessment Global factors considered only
Vietnam Initial National Communication to IPCC on Climate Change Impacts	+33 cm by 2050 along entire coastline; +45 cm by 2070. Therefore, possibly +63 cm by 2100.	2003 assessment by National Institute of Meterology and Hydrology Used average simulation of CSIRO
Vietnam Center for Hydrometeorology and the Environment	+21 cm by 2050; +48 cm by 2100	Unclear re dates, but assume early 1990s
Center for Environment Research, Education, and Development, Hanoi	+33 cm by 2050; +100 cm by 2100	Paper presented in Thailand, 2007
Bulletin of College of Science, University of the Ryukyus	Observations of 1.75 mm to 2.56 mm per year. Therefore, +13 cm to 2050 max +26 cm to 2100 max	Research paper, 2007, from Japanese University
IPCC 2007 Fourth Assessment Report	+15 cm from observations 1993–2003 to 2050 +30 cm from modeling +31 cm from observations 1993–2003 to 2100 +59 cm from modeling	No upper bound given for modeling results
Paper given at Conference on Urban Drainage, 2008. Ho Long Phi	+60 cm from 20 years of records +18 cm from simulations +120 cm from 20 years of records +36 cm from simulations	Results for Ho Chi Minh City only
Asian Development Bank Personal communication, 2008	+25 cm to 2050	2050 is considered to be the earliest year when there would be a statistically significant estimate of change

Source: World Bank 2009a.

actual effective sea level rise amounts are in the order of several meters, considering that tidal ranges, waves, and storm surges are also increasing along with the sea level. In addition, the vertical resolution of commonly available DEM data (e.g., SRTM as used here) is 1 meter, which renders a submeter analysis impossible.

For the purposes of developing the LRAP, derivation of the inundated areas can be made solely based on an alleged spread of the sea over the land, dependent on the SRTM elevation only. All other factors that further influence the amount and distribution of coastal inundations (e.g., sea walls, dikes, interactions of seawater and river flow with backwater effects) cannot be taken into account in this simplified approach. For this purpose, hydrological modeling is required, linking marine and terrestrial hydraulic and hydrographical features for more accurate assessment and can be considered when preparing the detailed project proposal for the priority projects identified during LRAP development.

The LRAP may consider the areas of coastal inundation for assumed sea level rises of 1 m, 2 m, 3 m, and 5 m. The latter may represent a worse case (not necessarily the worst case) in the more remote future, but as recent climate research suggests, it might become reality. The project includes the effects of storm surges due to typhoons, which are a frequent phenomenon in the area.

To estimate the potential coastal inundations associated with sea level rise, the information on tidal ranges, wave heights, and storm surges in the Vietnamese area will need to be collected. Based on this information, table E.3 shows current variations in sea level heights.

Based on these current variations, the assessment used for LRAP development makes the following assumptions for the sea level rise scenarios, where the current figures are extrapolated. We add 2 m for tidal range, 1 m for waves, and a further 3 m for storm surges to every assumed sea level rise. That means that a coincidence of storm surges and high tides is included. This results in the inundation scenarios in table E.4 for the sea level rise scenarios of 1 m, 2 m, 3 m, and 5 m.

Consequently, the spread of the sea can be calculated in 1 m increments beginning with 1 m up to 11 m. The latter would constitute the maximum assumed inundation level for the 5 m sea level rise scenario. These assumptions neglect expected future increases of tidal ranges, wave heights, and storm surges, because too few firm assumptions on those can currently be found. Coastal inundation can be derived in the same way for all cities.

Table E.3 Current Variations in Sea Level Heights and Derived Maximum Height for Computing Coastal Inundation due to Sea Level Rise

Sea surface variation	Maximum height above current mean sea level for inundation modeling	Comments	Sources
Maximum tidal ranges	2 m Note: Only half of the total tidal range is added to the mean sea level	The maximum tidal range along the coast of the Red River Delta is approximately 4 m. Thus 2 m are added to the mean sea level.	http://www.arcbc.org.ph/wetlands/vietnam/vnm_redrivdel.htm
		Mekong Delta: Average daily tidal range varies between 3.5 m and 4.5 m in the East Sea	http://www.arcbc.org.ph/wetlands/vietnam/vnm_mekdel.htm
		Semi-diurnal tidal range at the estuaries of the Mekong Delta: 2.8–3.8 m	http://www.mrcmekong.org/download/Presentations/sediment-monitoring/S4_Nguyen_Sedimentation%20processes%20in%20the%20Mekong%20River%20delta.pdf
		Mekong Delta: In the East Sea the tide is semidiurnal but irregular and has a large tidal amplitude of 3 to 3.5 m	http://unesdoc.unesco.org/images/0012/001278/127849e.pdf
Mean wave height	1 m	Red River Delta: Mean wave height 0.88 m	http://www.megadelta.ecnu.edu.cn/main/upload/Thanh%20TD%20expanded%20ABS-HCM%20Jan%202004.pdf
		Mekong Delta (east sea): Mean wave height 0.9 m	http://www.mrcmekong.org/download/Presentations/sediment-monitoring/S4_Nguyen_Sedimentation%20processes%20in%20the%20Mekong%20River%20delta.pdf
Storm surges	3 m	Red River Delta: The surge range reaches 1 m every 2 typhoons, 2 m every 5 typhoons, and maximum 3 m	http://www.megadelta.ecnu.edu.cn/main/upload/Thanh%20TD%20expanded%20ABS-HCM%20Jan%202004.pdf
		During Typhoon Cecil, sea level rose by 3.1–3.3 m	http://www.nlcap.net/fileadmin/NCAP/Countries/Vietnam/NCAP.VN.CON-01.FinalReport.final.pdf

Source: Geoville Group.

Table E.4 Inundation Heights Based on the Sea Level Rise Scenarios

Added sea level variation factors	Sea level rise 1 m	Sea level rise 2 m	Sea level rise 3 m	Sea level rise 5 m
Tidal range/2: 2 m	1 m + 2 m = 3 m	2 m + 2 m = 4 m	3 m + 2 m = 5 m	5 m + 2 m = 7 m
Mean waves: 1 m	3 m + 1 m = 4 m	4 m + 1 m = 5 m	5 m + 1 m = 6 m	7 m + 1 m = 8 m
Storm surges: 3 m	4 m + 3 m = 7 m	5 m + 3 m = 8 m	6 m + 3 m = 9 m	8 m + 3 m = 11 m

Source: Geoville Group.

F. GIS Data Compatibility and Technology Issues

Geographic information system data are collected from various sources in different formats. Proper projection information on each map layer should be collected in order to overlay the various map layers. There are many commercially developed GIS software packages (table F.1), each with a different combination of functionalities and operating with its own data formats. Even though they provide some degree of data conversion functionality, in most cases GIS data conversion across different formats is limited and poses a significant obstacle to users.

MapInfo is recommended for LRAP mapping exercises. It was widely used in Vietnam and provides easy conversion to and from more versatile ArcGIS shape files. However, MapInfo does not support sophisticated spatial analysis functionalities.

A more versatile option is to use ArcView with Spatial Analyst Extension for mapping and spatial analysis exercises, as it provides more flexible spatial analyst functionalities such as layer, integration, and summary tabulation statistics by spatially joining different layers. To use ArcView, data available to the city in other GIS data formats will need to be converted to the ArcView shapefile format.

Converting AutoCAD files to shapefile format consists of two processes. The first is geometry conversion. This can be done either automatically (if polylines), partially automated, or with manual interaction (if polygons). No attribute information is attached to the geometric objects during this process. The second process attaches attributes and annotations to the geometry. This process is done manually through object-by-object comparison between AutoCAD mapping output/legends and the converted geometric objects from the first process.

MapInfo to shapefile conversion is a relatively easy and automated process; this is because the software contains a built-in functionality called the Universal Translator.

Table F.1 Popular GIS Software Packages

Package	Description
ArcInfo	ArcInfo is one of the most comprehensive GIS software packages. It includes all functionality of ArcView and ArcEditor and adds advanced geoprocessing and spatial analysis capacities, such as map automation, data conversion, database management, map overlay and spatial analysis, interactive display and query, graphic editing, and address geocoding.
ArcView	ArcView is one of the most popular desktop GIS and mapping software packages. It provides data visualization, query, analysis, and integration capabilities along with the ability to create and edit geographic data. However, it is more oriented toward map display than database management.
AutoCAD Map 3D	AutoCAD Map 3D is a GIS software package built on the capabilities of AutoCAD software for automated drafting and design. Since this package is extensively used in planning, engineering, and architectural contexts, users can easily build on their existing knowledge. The software supports topology, query, data management, thematic mapping, and map editing/digitizing using extensive tools. It has only limited spatial analysis functionalities and is not easily interchangeable with other GIS software files.
MapInfo	MapInfo was one of the first GIS programs to perform desktop mapping. This software package is well distributed and has many user groups and a broad variety of applications.
Maptitude	Maptitude is a GIS software package that works under the Windows operating system. It uses Windows object linking and embedding, and comes with a considerable amount of geocoded and system-ready data on CD-ROM.
MicroStation MGE	MicroStation MGE is a widely distributed layer-based GIS software package. An extensive set of add-on modules allows users to configure GIS capability around their specific needs. The layered implementation allows efficient storage structures for the geometry and linkages to relational database records.

Source: Geoville Group.

Other GIS data formats can be converted to their sister AutoCAD or MapInfo formats and then to shapefile format following the same procedure, or can be converted directly to shapefile format.

G. Dong Hoi Matrix of Government Plans

Sector or functional area	Responsible institution	Relevant program	Status
Flood protection	Quang Binh Department of Construction	Embankment of Nhat Le River from segment Dai bridge to Nhat Le bridge: 3 km	Completed (1999–2005)
	City Environmental Sanitation Project Management Unit	Coastal Cities Environmental Sanitation Project	Ongoing (2006–14)
	City Environmental Sanitation Project Management Unit	Embankment for Phong Thuy Channel and Cau Rao River	Ongoing (2007–10)
	Central Government and Quang Binh Department of Transportation	Extension of bridges and sewer system for roads and railway lines to ensure flood drainage	Ongoing (2008–20)
Environment sanitation	Department of Culture, Information and Tourism	Embankment of city moat	Completed
Urban drainage and flood protection	Environmental Sanitation Project Management Unit under Quang Binh Provincial People's Committee	Coastal Cities Environmental Sanitation Project	Ongoing (2006–14)
		Embankment for Phong Thuy Channel and Cau Rao River	Ongoing (2007–10)
		Rehabilitation and construction of new sewers in some areas in city center	Ongoing (2007–10)
Coastal protection	Project Management Unit under Dong Hoi City People's Committee	Embankment of Nhat Le River from segment Dai bridge to Nhat Le bridge: 3km	Completed
Wastewater treatment	Environmental Sanitation Project Management Unit under Quang Binh Provincial People's Committee	Coastal Cities Environmental Sanitation Project	Ongoing (2006–14); proposed (2011–14)
Solid waste management	Environmental Sanitation Project Management Unit under Quang Binh Provincial People's Committee	Coastal Cities Environmental Sanitation Project	Ongoing (2006–14)
		Clean Healthy City Partnership	Ongoing (2007–09); proposed (2010–14)

Source: Authors.

H. Dong Hoi Project Information Sheet: Coastal Cities Environmental Sanitation Project

1. Title of Project: Coastal Cities Environmental Sanitation Project

2. Funding Agency Type (CPC/PPC/central government/donor), Name of Agency, Total Project Cost, and Earmarked Funds:

Donor—The World Bank
Project Cost—$38 Million
Earmarked Budged—$38 Million

3. Implementation Agency: Environmental Sanitation Project Management Unit (ES-PMU) under Quang Binh Provincial People's Committee

4. Month/Year Starting and Ending: December 31, 2006 to May 31, 2014

5. Areas of Implementation (wards/villages):

a. **Citywide:** None
b. **Target Area 1:** None
c. **Target Area 2:** Bac Ly, Nam Ly
d. **Target Area 3:** None
e. **Other areas:** Bong My, Dong Phu, Hai Dinh

6. Project Classification (project may meet multiple classifications):

a. **Developmental—Yes/No**
b. **Climate Change Mitigation—Yes/No**
c. **Climate Change Adaptation—Yes/No**
d. **Disaster Risk Management—Yes/No**

7. Types of Vulnerabilities Addressed:

a. **Disaster: Preparedness—Yes/No (Extent: High/Medium/Low)**
b. **Disaster: Mitigation—Yes/No (Extent: High/Medium/Low)**
c. **Disaster: Response—Yes/No (Extent: High/Medium/Low)**
d. **Disaster: Prevention—Yes/No (Extent: High/Medium/Low)**
e. **Disaster: Awareness & Sensitization—Yes/No (Extent: High/Medium/Low)**
f. **Disaster: Other (please specify)—Yes/No (Extent: High/Medium/Low)**
g. **Social: Age—Yes/No (Extent: High/Medium/Low)**
h. **Social: Gender—Yes/No (Extent: High/Medium/Low)**
i. **Social: Education—Yes/No (Extent: High/Medium/Low)**
j. **Social: Health—Yes/No (Extent: High/Medium/Low)**
k. **Social: Public Health & Sanitation—Yes/No (Extent: High/Medium/Low)**
l. **Social: Education, Employability & Training—Yes/No (Extent: High/Medium/Low)**
m. **Social: Other (please specify)—Yes/No (Extent: High/Medium/Low)**
n. **Economic: Income—Yes/No (Extent: High/Medium/Low)**
o. **Economic: Employment—Yes/No (Extent: High/Medium/Low)**
p. **Economic: Other (please specify)—Yes/No (Extent: High/Medium/Low)**
q. **Governance: Enhancing Delivery Mechanism—Yes/No (Extent: High/Medium/Low)**
r. **Governance: Other (please specify)—Yes/No (Extent: High/Medium/Low)**

9. Short Description of Project Objectives and Details (1 or 2 paragraphs highlighting the main objectives):

The project has 5 components relevant to development, climate change impacts, and disaster risk management:

Component 1—Flood control, drainage, and wastewater collection

The project will improve the collection of sewage by building new sewers, interceptors, rehabilitating existing sewers, and transporting the wastes to new treatment plants. Drainage will be provided by rehabilitating existing drains, constructing new drains where regular flooding occurs, and enhancing the capacity of flood retention ponds.

Existing combined sewer system will be utilized to the greatest extent possible in the central urban core areas with high population densities. Interceptor sewers will be constructed to pick up flows that currently discharge at a number of locations along the sea front or into rivers. In newly developing areas separate or combined systems will be constructed, depending on assessments of cost-effectiveness.

Component 2—Wastewater treatment plant

New wastewater treatment plant will be built during Phase 2 of the project to meet Vietnamese national effluent standards. In Dong Hoi a single new treatment plant serving the city will be constructed and the existing plant at the city hospital will be rehabilitated.

Component 3—Solid waste management

The collection of solid wastes will be improved and they will be transported to new or existing sanitary landfills for final disposal. In Dong Hoi a sanitary landfill is under development with bilateral funding and the project will provide additional equipment or functionality as determined during implementation.

Solid waste management (SWM) collection equipment will be financed. The amount and phasing of the SWM equipment will follow demand over the project life, and will take account of possible PPP activities.

In Dong Hoi the facilities for safe disposal of medical waste will be constructed. These will be operated by the Urban Works Company (UWC) under contract with the hospital.

Component 4—Household Revolving Fund and School Sanitation Program

Revolving funds will be established in each city to provide small loans for construction of household sanitation facilities. The funds will be managed by the Women's Union according to the procedures set out in the household revolving fund manual. Eligibility criteria and loan terms and conditions are designed to ensure that low income households are able to access and to pay back the loans.

Water supply and sanitation facilities will be built at city schools in response to demand from those schools. Demand assessment and proposed investment for different types of schools will follow the design standards set by the Ministry of Education (MoE).

Component 5—Capacity Building and Project Implementation

Capacity building for the service providers and city departments including a) institutional study to establish long-term structure and staffing for service providers; b) purchase, installation, and commissioning of financial management, management information, and billing/collection software for the service providers, and training in its use; c) joint development, with other city departments, of procedures and plans to support operation and management of new or rehabilitated project facilities; d) technical and managerial training to the service providers, including operation and maintenance of the facilities and in financial planning; e) workshops and study tours; and f) miscellaneous other capacity building activities.

Capacity building for design and implementation of a Healthy City Partnership (HCP) including a) development of the framework for design and implementation of the HCP; b) implementation of the HCP including training and public awareness, small investments in goods and works, and small grants; and c) preparation and delivery of public awareness campaigns to support sanitation behavior change and explain benefits from the project and its costs.

I. Hanoi: Ranking Adaptation Priorities

No.	Proposed measure	Where	Complexity[a]	Cost[a]	Benefit[a]	Status[b]	Type[c]	Time frame[d]	Priority[a]
1	Strengthen dike system to protect city (maintenance excluded)	New Hanoi; Old Hanoi	M	H	M	E	I	L	H
2	Strengthen sluice gate system	New Hanoi; northwest—Tx. Son Tay, Phuc Tho, Dan Phuong	M	M	M	E	I	M	H
3	Strengthen river banks; avoid natural resource exploitation—replace sand removed from the river banks	New Hanoi; northwest—Tx. Son Tay, Phuc Tho, Dan Phuong	L	L	M/H		I	S/M	H
4	Dredge and clear riverbeds and unlock river flows to ensure prompt flood discharge in the rivers flowing through the city	New Hanoi; along the Dan Phuong, Old Hanoi	M	M	H	E	I	M	H
5	Dredge and clear channels	New Hanoi; Old Hanoi	M	M	H	E	I	M	H
6	Strengthen urban drainage system	New Hanoi; Old Hanoi	M	H	H	E	I	L	H
7	Scenario building for climate change impacts on floods and inundation (temperature raising, precipitation changes, storms, extreme events)	New Hanoi	M/H	M	H	E	S	M[e]	H
8	Data and information collection for sectoral study about disaster risk management and climate change in New Hanoi to improve spatial mapping exercise and derivation of sectoral measures	New Hanoi; in particular, Old Hanoi, Hoai Duc, Ha Dong, Dong Anh, Me Linh	L	L	M	E	S	S/M	M
9	Enhance coordination of flood emergency and rescue activities and define clear responsibilities at lower level; improve emergency planning	Old Hanoi; northern and central— Ba Vi, Tx. Son Tay, Phuc Tho, Dan Phuong, Chuong My, My Duc	M (political)	L	M/H	E	S	S/M	M
10	Building code modification to include more detail on structures, materials, and locations to prevent flooding impacts	Old Hanoi; New Hanoi	M (political)	L/M	M	E	S	S	H

No.	Proposed measure	Where	Complexity[a]	Cost[a]	Benefit[a]	Status[b]	Type[c]	Time frame[d]	Priority[a]
11	Training activities on emergency and rescue at district level	Old Hanoi, northern—Ba Vi, Tx. Son Tay, Phuc Tho, Dan Phuong; Old Hanoi, southern and central Chuong My, My Duc	L	L		E	S	S	H
12	Afforestation and reforestation of upstream forests to avoid landslide and mudslide	Old Hanoi; northern—Ba Vi, Tx. Son Tay, Phuc Tho, Dan Phuong	M	L/M	H	N	O	S	H
13	Strengthen clean water supply system; enhance access to clean water	Old Hanoi in particular; New Hanoi	M	M/H	H	E	O	M/L	H
14	Strengthen solid waste management system; increase waste disposal and collection system	Old Hanoi in particular; New Hanoi	M	M	H	E	O	M	H
15	Strengthen clean water supply system; enhance access to clean water	Vong Xuyen, Linh Nam, Van Choung	M/H	M/H	H	E	O	M/L	H
16	Strengthen solid waste management system; increase waste disposal and collection system	Vong Xuyen, Linh Nam, Van Choung	M	M/H	M/H	E	O	M/L	H
17	Provide rescue equipment (boats)	Vong Xuyen	L	L	H	E	I	S	H
18	Strengthen sewerage system in all wards in old Hanoi to reduce wastewater to Linh Quang and Van Chuong Lakes, and extra wastewater during floods	Van Choung	H	H	H	E	O	L	H
19	Training at ward level on emergency and rescue programs and flood prevention	Vong Xuyen, Linh Nam, Van Choung	L	L	H	E	S	S	H
20	Afforestation and reforestation of upstream forests to avoid landslide and mudslide	Vong Xuyen	M/L	L	H	N	O	S/M	H

Source: Authors.

a. H = high; M = medium; L = low.

b. E = extension; N = new.

c. I = infrastructure; S = soft; O = other.

d. S = short (1 year); M = medium (1–3 years); L = long (3+ years).

e. MONRE produces a scenario for seven zones; updates and downscaling expected by 2012.

J. Dong Hoi Proposed Adaptation Measure

1. Title of Project: Improving medical facilities in hospitals and ward clinics—to improve disaster risk management capability:

a. Hospitals should have well-equipped trauma centers

b. Hospitals and medical clinics should have other necessary emergency treatment equipment

c. Hospitals and medical clinics should develop and regularly practice their own disaster management plans

2. Proposed Implementation Agency or Agencies: Department of Health (Vietnam-Cuba Friendship Hospital), Dong Hoi City People's Committee (Community Health Clinics)

3. Expected Project Cost:

4. Expected Project Duration: 2 years

5. Areas of Implementation (names of wards/villages):

a. Citywide: Vietnam-Cuba Friendship Hospital
b. Target Area 1: Community Health Clinics
c. Target Area 2: Community Health Clinics
d. Target Area 3: Community Health Clinics
e. Other areas: Community Health Clinics

6. Specific Vulnerability in Target Areas That Is Addressed by the Proposed Project: Medical first response after disasters, tertiary care of serious injuries after disasters

7. Is this project an extension of an ongoing or proposed project to a new area? Yes/No

8. Is this project an increase in scope (or another phase) of an ongoing or proposed project in the same area where the project is being implemented? Yes/No

9. Has any project with similar scope or objectives been implemented in the city during the last 10 years (If Yes, specify implementing agencies and project duration)? Yes/No

10. Project Classification (project may meet multiple classifications):

a. Developmental—Yes/No
b. Climate Change Mitigation—Yes/No
c. Climate Change Adaptation—Yes/No
d. Disaster Risk Management—Yes/No
e. Other (please specify)

11. Categories of Vulnerabilities Addressed by the Proposed Project:

a. Disaster: Preparedness— Yes/No (Extent: High/Medium/Low)
b. Disaster: Mitigation—Yes/No (Extent: High/Medium/Low)
c. Disaster: Response—Yes/No (Extent: High/Medium/Low)
d. Disaster: Prevention—Yes/No (Extent: High/Medium/Low)
e. Disaster: Awareness & Sensitization—Yes/No (Extent: High/Medium/Low)
f. Disaster: Other (please specify)—Yes/No (Extent: High/Medium/Low)
g. Social: Age—Yes/No (Extent: High/Medium/Low)
h. Social: Gender—Yes/No (Extent: High/Medium/Low)
i. Social: Education—Yes/No (Extent: High/Medium/Low)
j. Social: Health—Yes/No (Extent: High/Medium/Low)
k. Social: Public Health & Sanitation—Yes/No (Extent: High/Medium/Low)

l. **Social: Education, Employability & Training—Yes/No (Extent: High/Medium/Low)**
m. **Social: Other (please specify)—Yes/No (Extent: High/Medium/Low)**
n. **Economic: Income—Yes/No (Extent: High/Medium/Low)**
o. **Economic: Employment—Yes/No (Extent: High/Medium/Low)**
p. **Economic: Other (please specify)—Yes/No (Extent: High/Medium/Low)**
q. **Governance: Enhancing Delivery Mechanism—Yes/No (Extent: High/Medium/Low)**
r. **Governance: Other (please specify)—Yes/No (Extent: High/Medium/Low)**
s. **Climate Change: Reducing GHG Emissions—Yes/No (Extent: High/Medium/Low)**
t. **Climate Change: Other mitigation—Yes/No (Extent: High/Medium/Low)**
u. **Climate Change: Adaptation—Yes/No (Extent: High/Medium/Low)**

12. Capacity building or training requirements of Implementation Agencies for carrying out this program (give details if capacity-building or training is required).

The program requires considerable capacity-building of medical professionals. Currently the hospital and health clinics experience a severe shortage of trained medical professionals.

13. Short Description of Project Objectives and Details (1 or 2 pages highlighting the main objectives, scope or extent of project, expected deliverables, anticipated benefits, etc.):

a. Main Project Objectives:

The project aims to improve the medical facilities in Dong Hoi City to enable them to better respond to victims of natural disasters and those due to climate change impacts.

Another objective of the project is to help to establish a medical trauma center in Vietnam-Cuba Friendship Hospital.

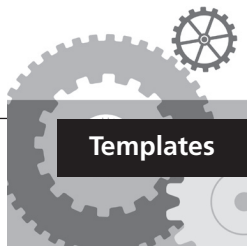
Another objective of the project is to enable the hospitals and community medical clinics to develop their disaster management plans considering various likely hazards and to regularly practice and update the plans.

b. Project Details, Main Deliverables, and Benefits:

The community health clinics, managed by the Dong Hoi City People's Committee, are ill-equipped in terms of personnel and equipment. These health clinics do not have the essential equipment to manage any medical emergency or to stabilize the patient in order to shift them to a better equipped facility. Even under a nondisaster situation, these community clinics are unable to provide adequate medical support to accident victims or workers with onsite injury. One objective of the project is to equip the community health clinics with the minimum level of equipment and provide required training to the doctors and other medical professionals on proper use of this equipment for emergency medical care. This will not only equip these community health clinics to act as the point of first medical referral in the event of a disaster, but will also help to enhance the quality of medical facilities available to the population during other nondisaster periods.

Another objective of the project is to help to establish a medical trauma center in Vietnam-Cuba Friendship Hospital. This will enable it to act as a referral hospital and provide tertiary care for serious medical cases. The hospital currently has some medical equipment useful for trauma management, but a large number of other medical equipment are required for effective trauma care. This project aims to equip the hospital with necessary equipment for trauma care under both nondisaster period, as well as following any disaster due to the impact of natural hazards or climate change. The project also aims to train the doctors and other medical professionals in developing and implementing suitable trauma-care protocol in the hospital.

Another objective of the project is to enable the hospitals and community medical clinics to develop their disaster management plans considering various likely hazards and to regularly practice and update the plans. The hospital disaster management plans shall be integrated with the community and city disaster management plans.



1. City Typology and Risk Characterization (Hotspot Assessment) Matrix
2. Institutional Mapping
3. Matrix of Government Plans
4. Project Information Sheet
5. Proposed Programs Based on Group Analysis
6. Ranking Adaptation Measure Priorities
7. Proposed High-Priority Programs
8. Communications Strategy
9. Stakeholder Mapping

1. City Typology and Risk Characterization (Hotspot Assessment) Matrix

City Description and Size Characteristics

A. City description	
1. City location	
a. In a coastal area? (Y or N)	
b. On or near mountain area? (Y or N)	
c. On inland plain? (Y or N)	
d. On inland plateau? (Y or N)	
e. Near to or on a river(s)? (Y or N)	
f. Near earthquake fault lines? (Y or N)	
B. Size characteristics of city	
1. Resident population (VH, H, M, or L)	
VH = Greater than 5 million H = 2 million–5 million M = 0.5 million–2 million L = Less than 0.5 million	
2. Population growth during last 10 years (H, M, or L)	
H = Greater than 10% M = Between 2%–10% L = Less than 2%	
3. Floating population (VH, H, M, or L)	
VH = Greater than 30% of resident population H = Between 20%–30% of resident population M = Between 10%–20% of resident population L = Less than 10% of resident population	
4. Area in square kilometers (km^2)	
5. Maximum population density (day or night) (H, M, or L)	
H = Greater than 2,000 persons per km^2 M = Between 1,000–2,000 persons per km^2 L = Less than 1,000 persons per km^2	

Governance Structure, City Management, and Financial Resources

C. Governance structure as related to disaster risk management	
1. Appointed head of government? (Y or N)	
a. Term of assignment (Years)	
2. Elected head of government (Y or N)	
a. Term of elected officials (Years)	
3. Local government office structure: does it have…	
a. Disaster risk management department? (Y or N)	
b. Environment, sustainability, or climate change department? (Y or N)	
c. Are (a) and (b) in the same department? (Y or N)	
4. Other government office structure (state, national)*: does it have…	
a. Disaster risk management department? (Y or N)	
b. Environment, sustainability, or climate change department? (Y or N)	
c. Are (a) and (b) in the same department? (Y or N)	
D. City management on climate change and disaster risk management	
1. Responsibilities clearly specified? (Y or N)	
2. Responsibility for climate change management established? (Y or N)	
3. Responsibility for disaster risk management established? (Y or N)	
4. Authority to contract for services? (Y or N)	
E. Financial resources	
1. Total budget	
2. From local taxes and levies (% of total)	
3. From state/national government grants and devolutions (%)	
4. From domestic market (%)	
5. From international market (%))	
6. From external or multilateral lending agencies (%)	

Built Environment

F. Built environment	
1. Does the city have urban growth master plans? (Y or N)	
2. Does the city have urban development and land-use plans? (Y or N)	
a. Population in authorized development (% of total)	
b. Population in informal or temporary settlements (% of total)	
c. Population density of informal settlements (H, M, or L)	
H = Population of informal settlements >20% of total M = Population of informal settlements <20% but >10% of total L = Population of informal settlements <10% of total	
d. Population in old tenements and historical development (% of total or H, M, or L using ratings in 2c)	
3. Does the city have building codes? (Y or N)	
a. What is level of compliance? (% compliant buildings)	
4. Observed vulnerability of buildings in past natural disasters (extent of disruption of building functionality)	
a. Informal buildings (H, M, or L)	
H = >15% of informal buildings highly vulnerable M = 5%–15% of informal buildings highly vulnerable L = <5% of informal buildings highly vulnerable	
b. Historic buildings (H, M, or L)	
c. New and formal developments (H, M, or L)	
H = >5% of new and formally developed buildings highly vulnerable M = 1%–5% of new and formally developed buildings highly vulnerable L = <1% of new and formally developed buildings highly vulnerable	

Political and Economic Impacts

G. Political impact of disasters	
1. Is the city a national/provincial capital or where a large number of decision makers live? (Y or N)	
2. Is impact of disaster in the city likely to influence political activity in areas far away from affected regions? (Y or N)	
H. Economic impact of disasters	
1. Is the city a major center of economic activity in regional or national context? (Y or N)	
2. Do the following sectors have major activity in the city?	
a. Industrial sector? (Y or N)	
b. Services sector? (Y or N)	
c. Financial sector? (Y or N)	
d. Tourism and hospitality sectors? (Y or N)	
e. Agriculture, aquaculture, and rural sectors? (Y or N)	

Hazards and Disaster Response System

I. Threat of natural hazards	
1. Earthquake? (Y or N)	
2. Windstorm? (Y or N)	
3. River flood? (Y or N)	
4. Flash rainwater flood or extreme precipitation? (Y or N)	
5. Tsunami? (Y or N)	
6. Drought? (Y or N)	
7. Volcano? (Y or N)	
8. Landslide? (Y or N)	
9. Storm surge? (Y or N)	
10. Extreme temperature? (Y or N)	
J. Disaster response system	
1. Does a disaster response system exist in the city? (Y or N)	
2. Is the response system comprehensive and equipped for all natural hazards specified? (Y or N)	
3. Is the disaster response system regularly practiced? (Y or N)	
4. Is the disaster response system regularly updated? (Y or N)	

Climate Change Impacts

K. Climate change impact	
1. Is the impact of climate change on the city known? (Y or N)	
2. Are the following sectors vulnerable to the consequences of climate change?	
a. Built environment? (Y or N)	
b. Cultural and religious heritage? (Y or N)	
c. Local business, industry, and economy? (Y or N)	
d. Energy generation and distribution system? (Y or N)	
e. Health care facilities? (Y or N)	
f. Land use? (Y or N)	
g. Transportation system? (Y or N)	
h. Parks and recreation areas? (Y or N)	
i. Tourism? (Y or N)	
j. Agriculture and rural? (Y or N)	
3. Is climate change assessment based on local studies instead of regional/ global models? (Y or N)	
4. Does the city have a climate change strategy (maybe as a component of national policy)? (Y or N)	
5. Does the city have climate change programs in place? (Y or N)	
6. If yes, do the climate change programs consider:	
a. Mitigation? (Y or N)	
b. Adaptation? (Y or N)	
c. Resilience? (Y or N)	

Vulnerability Assessment: Level of Preparedness/Readiness by Hazard Type and Sector

Hazard type	Sector			
	Industrial	Services	Financial	Tourism and hospitality
Earthquake (H, M, or L)				
Windstorm (H, M, or L)				
River flood (H, M, or L)				
Flash rainwater flood or extreme precipitation (H, M, or L)				
Tsunami (H, M, or L)				
Drought (H, M, or L)				
Volcano (H, M, or L)				
Landslide (H, M, or L)				
Storm surge (H, M, or L)				
Extreme temperature (H, M, or L)				

Note: Rate the level of preparedness for each event for each sector. H = high level of preparedness and readiness to respond to disaster and hazard; M = somewhat high level and the basic/key informants are present (a basic disaster management system is in place, but may not be comprehensive or consider specific hazards); L = low (no disaster management system, no warning system, etc.).

Vulnerability Assessment: Specific Climate Factors by Sector

Sector	Temperature rise	Precipitation change	Sea level rise
Built environment (H, M, or L)			
Cultural and religious heritage (H, M, or L)			
Local business, industry, economy (H, M, or L)			
Energy generation/distribution (H, M, or L)			
Health care facilities (H, M, or L)			
Land use (H, M, or L)			
Transportation system (H, M, or L)			
Parks and recreation areas (H, M, or L)			
Social equity system (H, M, or L)			
Water management (H, M, or L)			
Tourism (H, M, or L)			

Note: Rate the level of vulnerability in each sector. H = very important consequences and priority for action; M = important and should be considered in city development plans; L = unimportant.

2. Institutional Mapping

Vulnerability	Nature of vulnerability	Institution	Institution type

3. Matrix of Government Plans

Sector or functional area	Responsible institution	Relevant program	Status

4. Project Information Sheet

1. Title of Project:
2. Funding Agency Type (CPC/PPC/central government/donor), Name of Agency, Total Project Cost, and Earmarked Funds:
3. Implementation Agency:
4. Month/Year Starting and Ending:
5. Areas of Implementation (wards/villages): **a. Citywide:** **b. Target Area 1:** **c. Target Area 2:** **d. Other areas:**
6. Project Classification (project may meet multiple classifications): **a. Developmental—Yes/No** **b. Climate Change Mitigation—Yes/No** **c. Climate Change Adaptation—Yes/No** **d. Disaster Risk Management—Yes/No**
7. Types of Vulnerabilities Addressed: **a. Disaster: Preparedness—Yes/No (Extent: High/Medium/Low)** **b. Disaster: Mitigation—Yes/No (Extent: High/Medium/Low)** **c. Disaster: Response—Yes/No (Extent: High/Medium/Low)** **d. Disaster: Prevention—Yes/No (Extent: High/Medium/Low)** **e. Disaster: Awareness & Sensitization—Yes/No (Extent: High/Medium/Low)** **f. Disaster: Other (please specify)—Yes/No (Extent: High/Medium/Low)** **g. Social: Age—Yes/No (Extent: High/Medium/Low)** **h. Social: Gender—Yes/No (Extent: High/Medium/Low)** **i. Social: Education—Yes/No (Extent: High/Medium/Low)** **j. Social: Health—Yes/No (Extent: High/Medium/Low)** **k. Social: Public Health & Sanitation—Yes/No (Extent: High/Medium/Low)** **l. Social: Education, Employability & Training—Yes/No (Extent: High/Medium/Low)** **m. Social: Other (please specify)—Yes/No (Extent: High/Medium/Low)** **n. Economic: Income—Yes/No (Extent: High/Medium/Low)** **o. Economic: Employment—Yes/No (Extent: High/Medium/Low)** **p. Economic: Other (please specify)—Yes/No (Extent: High/Medium/Low)** **q. Governance: Enhancing Delivery Mechanism—Yes/No (Extent: High/Medium/Low)** **r. Governance: Other (please specify)—Yes/No (Extent: High/Medium/Low)** **s. Climate Change: Reducing GHG Emissions—Yes/No (Extent: High/Medium/Low)** **t. Climate Change: Other mitigation—Yes/No (Extent: High/Medium/Low)** **u. Climate Change: Adaptation—Yes/No (Extent: High/Medium/Low)**
8. If the proposed project does not directly tackle, or adequately tackle, the vulnerability, can the project be expanded/modified to include such? If so, how/what would it take, etc.?
9. Short Description of Project Objectives and Details (1 or 2 paragraphs highlighting the main objectives and important details): **a. Project Objectives:** **b. Important Project Details:**

5. Proposed Programs Based on Gap Analysis

Gap being addressed	Criticality of gap (H/M/L)	Program title	Hosting organization	Program priority (H/M/L)

6. Ranking Adaptation Measure Priorities

Rank										
Proposed measure										
Area										
Where in the city										
Institution to apply (name of authority)										
Complexity (H/M/L)										
Cost (H/M/L; define or exact)										
Benefit (H/M/L; define or exact)										
New/extension										
Type (infrastructure, soft, other)										
Time (S = 1 yr/M = 3 yrs/L = 3+ yrs)										
Priority (H/M/L)										

7. Proposed High-Priority Programs

1. Title of Project:

2. Proposed Implementation Agency or Agencies:

3. Expected Project Cost:

4. Basis for Cost Estimates:

5. Expected Project Duration:

6. Areas of Implementation (names of wards/villages):

a. **Citywide:**
b. **Target Area 1:**
c. **Target Area 2:**
d. **Target Area 3:**
e. **Other areas:**

7. Specific Vulnerability in Target Areas That Is Addressed by the Proposed Project:

8. Is this project an extension of an ongoing or proposed project to a new area? Yes/No

9. Is this project an increase in scope (or another phase) of an ongoing or proposed project in the same area where the project is being implemented? Yes/No

10. Has any project with similar scope or objectives been implemented in the city during the last 10 years (if Yes, specify implementing agencies and project duration)? Yes/No

11. Project Classification (project may meet multiple classifications):

a. **Developmental—Yes/No**
b. **Climate Change Mitigation—Yes/No**
c. **Climate Change Adaptation—Yes/No**
d. **Disaster Risk Management—Yes/No**
e. **Other (please specify)**

12. Categories of Vulnerabilities Addressed by the Proposed Project:

a. **Disaster: Preparedness— Yes/No (Extent: High/Medium/Low)**
b. **Disaster: Mitigation—Yes/No (Extent: High/Medium/Low)**
c. **Disaster: Response—Yes/No (Extent: High/Medium/Low)**
d. **Disaster: Prevention—Yes/No (Extent: High/Medium/Low)**
e. **Disaster: Awareness & Sensitization—Yes/No (Extent: High/Medium/Low)**
f. **Disaster: Other (please specify)—Yes/No (Extent: High/Medium/Low)**
g. **Social: Age—Yes/No (Extent: High/Medium/Low)**
h. **Social: Gender—Yes/No (Extent: High/Medium/Low)**
i. **Social: Education—Yes/No (Extent: High/Medium/Low)**
j. **Social: Health—Yes/No (Extent: High/Medium/Low)**
k. **Social: Public Health & Sanitation—Yes/No (Extent: High/Medium/Low)**
l. **Social: Education, Employability & Training—Yes/No (Extent: High/Medium/Low)**
m. **Social: Other (please specify)—Yes/No (Extent: High/Medium/Low)**
n. **Economic: Income—Yes/No (Extent: High/Medium/Low)**
o. **Economic: Employment—Yes/No (Extent: High/Medium/Low)**
p. **Economic: Other (please specify)—Yes/No (Extent: High/Medium/Low)**
q. **Governance: Enhancing Delivery Mechanism—Yes/No (Extent: High/Medium/Low)**
r. **Governance: Other (please specify)—Yes/No (Extent: High/Medium/Low)**
s. **Climate Change: Reducing GHG Emissions—Yes/No (Extent: High/Medium/Low)**
t. **Climate Change: Other mitigation—Yes/No (Extent: High/Medium/Low)**
u. **Climate Change: Adaptation—Yes/No (Extent: High/Medium/Low)**

13. Capacity building or training requirements of Implementation Agencies for carrying out this program (give details if capacity-building or training is required).

14. Short Description of Project Objectives and Details (1 or 2 pages highlighting the main objectives, scope or extent of project, expected deliverables, anticipated benefits, etc.):

a. Main Project Objectives:

b. Project Details, Main Deliverables, and Benefits:

8. Communications Strategy

1. **Review.** How have we been communicating in the past?

2. **Objectives.** What do we want our communications to achieve? Are our objectives SMART?

3. **Audience.** Who is our audience? What information do they need to act upon our work?

4. **Message.** What is our message? Do we have one message for multiple audiences or multiple messages for multiple audiences?

5. **Basket.** What kinds of communications "products" will best capture and deliver our messages?

6. **Channels.** How will we promote and disseminate our products? What channels will we use?

7. **Resources.** What kind of budget do we have for this? Will this change in the future? What communications hardware and skills do we have?

8. **Timing.** What is our timeline? Would a staged strategy be the most appropriate? What special events or opportunities might arise? Does the work of like-minded organizations present possible opportunities?

9. **Brand.** Are all of our communications products "on brand"? How can we ensure that we are broadcasting the right message?

10. **Feedback.** Did our communications influence our audiences? How can we assess whether we used the right tools, were on budget and on time, and had any influence?

Source: IDRC 2008.

9. Stakeholder Mapping

	Unmovable opponent	Opponent	Uncommitted/ uninvolved	Supportive	Extremely supportive
No effort					
Activate					
Reinforce					
Persuade					

ECO-AUDIT

Environmental Benefits Statement

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- 128 pounds of solid waste