DISSERTATION

CAPACITY BUILDING FOR FLOOD MANAGEMENT IN DEVELOPING COUNTRIES UNDER CLIMATE CHANGE

Submitted by

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY YOSHIHIRO KATSUHAMA ENTITLED "CAPACITY BUILDING FOR FLOOD MANAGEMENT IN DEVELOPING COUNTRIES UNDER CLIMATE CHANGE" BE ACCEPTED AS FULLFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

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ABSTRACT OF DISSERTATION

CAPACITY BUILDING FOR FLOOD MANAGEMENT

IN DEVELOPING COUNTRIES UNDER CLIMATE CHANGE

Climate change will bring new flood threats, especially in developing countries. In addition, the contexts surrounding flood management have been shifting globally. If developing countries are to address serious flood risks caused by insufficient infrastructure and lack of legislation and enforcement programs, they must improve institutional, organizational, and individual capacities for flood management systems. The research for this dissertation explored how to alleviate flood damage and achieve sound economic growth in developing countries in the context of a global paradigm shift in flood management under climate change with a focus on capacity building.

The research established a conceptual model to clarify the relationships between flood risks, elements of flood management systems, and the influence of institutional, organizational, and individual capacities on the system elements. The research also offered a tool to evaluate how capacity affects the systems and to identify the needs for capacity building. Additionally, the research established and tested capacity building methodologies for flood management in

developing countries under climate change, including both principles and the procedures to implement them.

Case studies in Jakarta, Indonesia and the Tokai region, Japan were analyzed to identify capacity building needs and constraints in developing countries as well as factors determining effectiveness of flood management systems. They showed that while institutional arrangements are essential for effective flood management, their effectiveness depends on the capacity to implement them. While infrastructure may mitigate flood damage, the limitations of infrastructure must be recognized and should not induce complacency. Awareness of flood threats and management by the local community is a key issue and data accessibility is fundamental to the flood management process. The conceptual model used here identified capacity-related flood management problems and their interrelationships clarified the needs for capacity building at institutional, organizational, and individual levels throughout the flood management processes.

Case studies in Manila, the Philippines and the Nyando river basin, Kenya led to the following principles of capacity building for flood management in developing countries under climate change: 1. Capacity to implement both structural and non-structural measures needs to be developed, 2. All institutional, organizational, and individual capacity is crucial, 3. Leadership and decision-making capacity are more necessary under increased flood risks, and 4. Capacity to secure the ‘three Es’ (effectiveness, efficiency, and equity) is the key to increasing feasibility of

flood management means. Then, capacity building procedures to implement the principles were formulated, which consisted of the processes of capacity assessments; integration of resources including formulation and prioritization of alternatives and implementation of priority measures; and human resources development to make the most use of the resources. The case studies also suggested that complexity of problems and levels of self-sufficiency differed between urban and rural areas regardless of the shared necessity of comprehensive capacity building.

Following the recent paradigm shift on public policy and the increasing complexity and uncertainty under climate change, the requirements to identify and solve problems in a comprehensive and integrated manner are even more important. Considering that problems in developing countries are more complex and intertwined than those in developed countries, the trade-offs between the requirements for flood management and the need to cope with flood risks in developing countries take on greater urgency.

Given these concerns, the research offered the tools to assess and improve flood management systems. Institutional, organizational, and individual capacity building based on appropriate problem identification and needs clarification is time-consuming yet ultimately, it is the fastest and the most inevitable road for effective flood management under climate change.

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ABBREVIATIONS

ABCWUA	Albuquerque/Bernalillo County Water Utility Authority
ADB	Asian Development Bank
ADRA	Adventist Development and Relief Agency (NGO)
AMAFCA	Albuquerque Metropolitan Arroyo Flood Control Authority
AR4	The IPCC Forth Assessment Report (2007)
AR5	The IPCC Fifth Assessment Report
APFM	The Associated Programme on Flood Management
BAKORNAS	Badan Koordinasi Nasional Penanggulangan Bencanaor Bakornas PB (National Disaster Management Coordinating Board, Indonesia, predecessor of BNPB)
Bappenas	Badan Perencanaan dan Pembangunan Nasional (National Development Planning Agency, Indonesia)
BC	Bernalillo County, New Mexico, USA
BDCC	Barangay Disaster Coordinating Council, the Philippines
BNPB	Badan Nasional Penanggulangan Bencana (National Board for Disaster Management, Indonesia)
CARE	Cooperative for Assistance and Relief Everywhere (NGO)
CDCC	City Disaster Coordinating Council, the Philippines
CERT	Community Emergency Response Team, USA
COA	City of Albuquerque, New Mexico, USA
CRS	Community Rating System, NFIP (USA)
DAC	Development Assistance Committee, OECD
DKI Jakarta	Daerah Khusus Ibukota Jakarta (Provincial Government of Jakarta)
DPU	Departemen Pekerjaan Umum (Ministry of Public Works, Indonesia)
DPWH	Department of Public Works and Highways, the Philippines
EPA	U.S. Environmental Protection Agency
ECDPM	European Centre for Development Policy Management
EFCOS	Effective Flood Control Operation System (The Manila metropolitan area)
EMO	Emergency Management Office, City of Albuquerque
EPA	United States Environmental Protection Agency
EU	European Union

FASID	Foundation for Advanced Studies on International Development
FEMA	The Federal Emergency Management Agency, USA
FFWS	Flood Forecasting and Warning Systems
FMS	Flood Management Systems
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH (Federal Ministry for Economic Cooperation and Development, Germany)
GTZ-SfDM	GTZ – Support for Decentralization Measures
GWP	Global Water Partnership
HC	Human Capacity
HFA	Hyogo Framework for Action
HRD	Human Resources Development
HWRP	Hydrology and Water Resources Programme of WMO
IDR	Indonesian Rupiah
IF Net	International Flood Network
IFM	Integrated Flood Management
IHE	International Institute for Hydraulic and Environmental Engineering (Present UNESCO-IHE)
IHP	International Hydrological Programme of UNESCO
IPCC	Intergovernmental Panel on Climate Change
IRC	International Water and Sanitation Centre
ISDR	United Nations International Strategy for Disaster Reduction
IT	Information Technology
IWRM	Integrated Water Resources Management
JABOTABEK	Jakarta urban area (Jakarta – Bogor – Tangerang – Bekasi)
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
JPY	Japanese Yen
JR	Japan Railway
Kab.	Kabupaten (Regency; Administrative Unit in Indonesia)
KSAs	Knowledge, Skills and Abilities
LBDA	Lake Basin Development Authority, Kenya
LDCs	Least Developed Countries

LEAD	Law, Environment and Development Journal
LGU	Local Government Unit, the Philippines
MDCC	Municipality Disaster Coordinating Council, the Philippines
MDGs	Millennium Development Goals
MLIT	Ministry of Land, Infrastructure, Transport and Tourism, Japan
MMDA	Metropolitan Manila Development Authority
MMDCC	Metro Manila Disaster Coordinating Council
MoEF	Ministry of Environment and Forests, Bangladesh
MOW	Ministry of Water and Irrigation, Kenya
MoWD	Ministry of Water Development, Kenya (ex-MOW)
MRGCD	Middle Rio Grande Conservancy District
MSSP	Ministry of State for Special Programmes, Office of the President, Kenya
NAPA	National Adaptation Programme of Action to Climate Change
NCDPP	National Calamity and Disaster Preparedness Plan (The Philippines)
NDCC	National Disaster Coordination Council, the Philippines
NEDECO	Netherlands Engineering Consultants
NEWATER	New Approaches to Adaptive Water Management under Uncertainty
NFIP	National Flood Insurance Program (USA)
NGO	Nongovernmental Organization
NLIRO	Non-Life Insurance Rating Organization of Japan
NOAA	National Oceanic and Atmosphere Administration, USA
NPO	Nonprofit Organization
NSO	National Statistics Office, Republic of the Philippines
O&M	Operation and Maintenance
OECD	Organization for Economic Cooperation and Development
Off-JT	Off-the-job Training
OJT	On-the-job Training
PAGASA	Philippines Atmospheric, Geophysical and Astronomical Services Administration
PD	Presidential Decree
PDCA	Plan, Do, Check, Action

PDCC	Provincial Disaster Coordinating Council, the Philippines
PMF	Probable Maximum Flood
PRRC	Pasig River Rehabilitation Commission
RDCC	Regional Disaster Coordinating Council, the Philippines
RIMAX	Risikomanagement extremer Hochwasserereignisse (Risk Management of Extreme Flood Events)
SANA	Sustainable Aid in Africa International (NGO)
SNV	Stichting Nederlandse Vrijwilligers (Foundation of Netherlands Volunteers; SNV Netherlands Development Organisation)
SRES	Special Report on Emissions Scenarios (IPCC, 2000)
TAR	The IPCC Third Assessment Report (2001)
TOR	Terms of Reference
UNCCC	United Nations Climate Change Conference
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Education, Science and Cultural Organization
UNESCO-IHE	UNESCO – Institute for Water Education
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations Inter-Agency Secretariat of the International Strategy for Disaster Reduction
USAID	United States Agency for International Development
USFS	United States Forest Services
VIRED	Victoria Institute for Research on Environment and Development International (NGO)
WB	The World Bank
WCD	World Commission on Dams
WFD	Water Framework Directive
WG	Working Group
WHO	World Health Organization
WMO	World Meteorological Organization
WWC	World Water Council

WWDR	The World Water Development Report
WWDR3	The World Water Development Report 3 (UNESCO, 2009b)
WWF	World Wide Fund for Nature (Formerly World Wildlife Fund)
WWF5	The 5th World Water Forum

CHAPTER 1

INTRODUCTION

1.1 Introduction

Climate change will bring new flood threats, especially in developing countries. It may increase the magnitude, frequency, and intensity of flood risks, and have a critical impact on national economic activities. Developing countries tend to face larger flood risks because of insufficient funds, inadequate infrastructure, lack of legislation and enforcement programs, and other flood management issues. Additional risk factors, such as lack of preparedness and response by authorities, add to the existing vulnerabilities and will exacerbate the consequences of flooding. Delay of implementing measures against climate change may lead to serious problems including economic stagnation and persistence of poverty, which amplify the current glaring disparity between developed and developing countries.

These negative impacts of floods are related to and made worse by inadequate institutional, social, organizational, and individual capacities required for flood management. The term “capacity” is defined as an enabling environment which contributes to formulating necessary outcomes to achieve a goal. The goal here is reduction of flood damage under climate

change, which is accelerating augmentation of negative impacts on the consequences of flooding. In contrast, the risks might be alleviated if appropriate measures are taken based on enhanced capacity. The physical safety and the confidence in security generated by the sufficient measures may contribute toward further economic development.

In addition, the contexts surrounding water resources management including flood management have been shifting following diversification of people's sense of values, more emphasis on environmental conservation, and other increasing complexities. This paradigm shift requires more comprehensive and integrated approaches in flood management.

In any process of flood management, the infrastructure and procedures are important to achieve goals. However, the capacity, which influences performance of organizations responsible for flood management, is paramount for making all elements of flood management function adequately. Especially in developing countries, gaps between available capacity and the urgency to cope with the flood risks remain high. Under these circumstances, it is required to formulate new capacity building methodologies for effective flood management.

The research for this dissertation (hereinafter referred to as the research) explores how to alleviate flood damage and achieve sound economic development in developing countries with a focus on capacity building. First, the research establishes a conceptual model of capacity building for flood management applicable in developing countries. The conceptual model is a

framework that explains how capacity affects flood management systems to reduce the negative consequences of flooding. Second, the conceptual model is applied to case studies to identify required capacity building to cope with the increased flood risks under climate change. Then, the research formulates and tests capacity building methodologies, which enable developing countries to reduce the new flood threats under climate change by enhancing flood management. The methodologies consist of principles of capacity building and procedures to implement the principles.

Figure 1.1 shows a map of the dissertation which describes each chapter's position and outcomes to achieve the research goal. **Chapter 1** provides a problem statement, research justification, literature review, and research design to set the stage. **Chapters 2** to **4** are the main part of the research, i.e. data analysis and interpretation. **Chapter 2** defines capacity building for flood management and establishes a conceptual model of capacity building applicable in developing countries. **Chapter 3** applies the conceptual model to case studies under existing conditions and under climate change. Then, the capacity building methodologies are formulated by examining how to cope with the increased flood risks and reduce negative consequences of flooding under climate change. **Chapter 4** evaluates project outcomes when we apply the capacity building methodologies. **Chapter 5** presents conclusions and recommendations derived from the research.

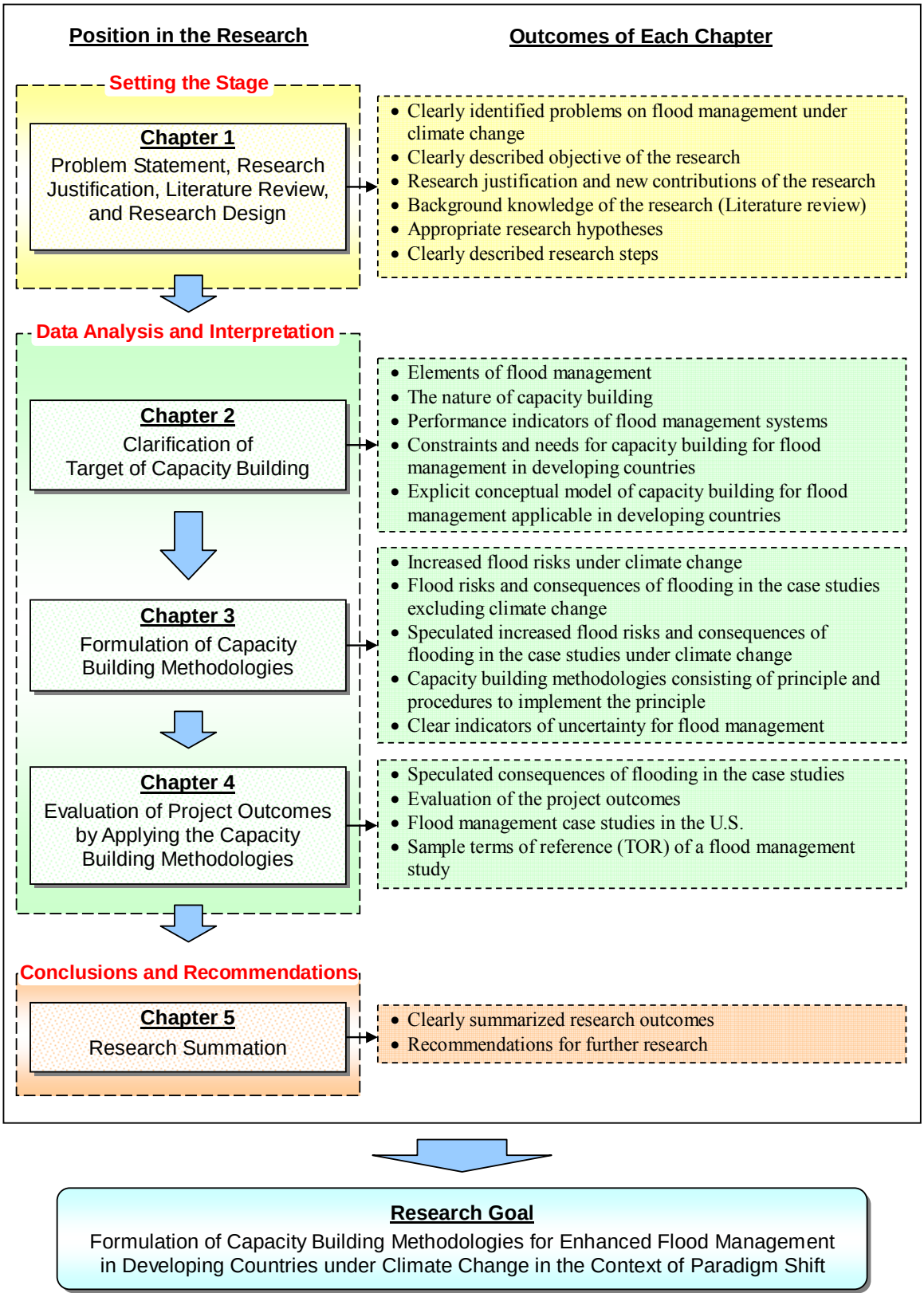

Figure 1.1 Map of the Dissertation

1.2 Problem Statement

Figure 1.2 shows the problems associated with flood management under climate change. The underlying transformation of the problems caused by climate change is represented by the 'three Vs': Volatility, Vulnerability, and inadequate Vigilance.

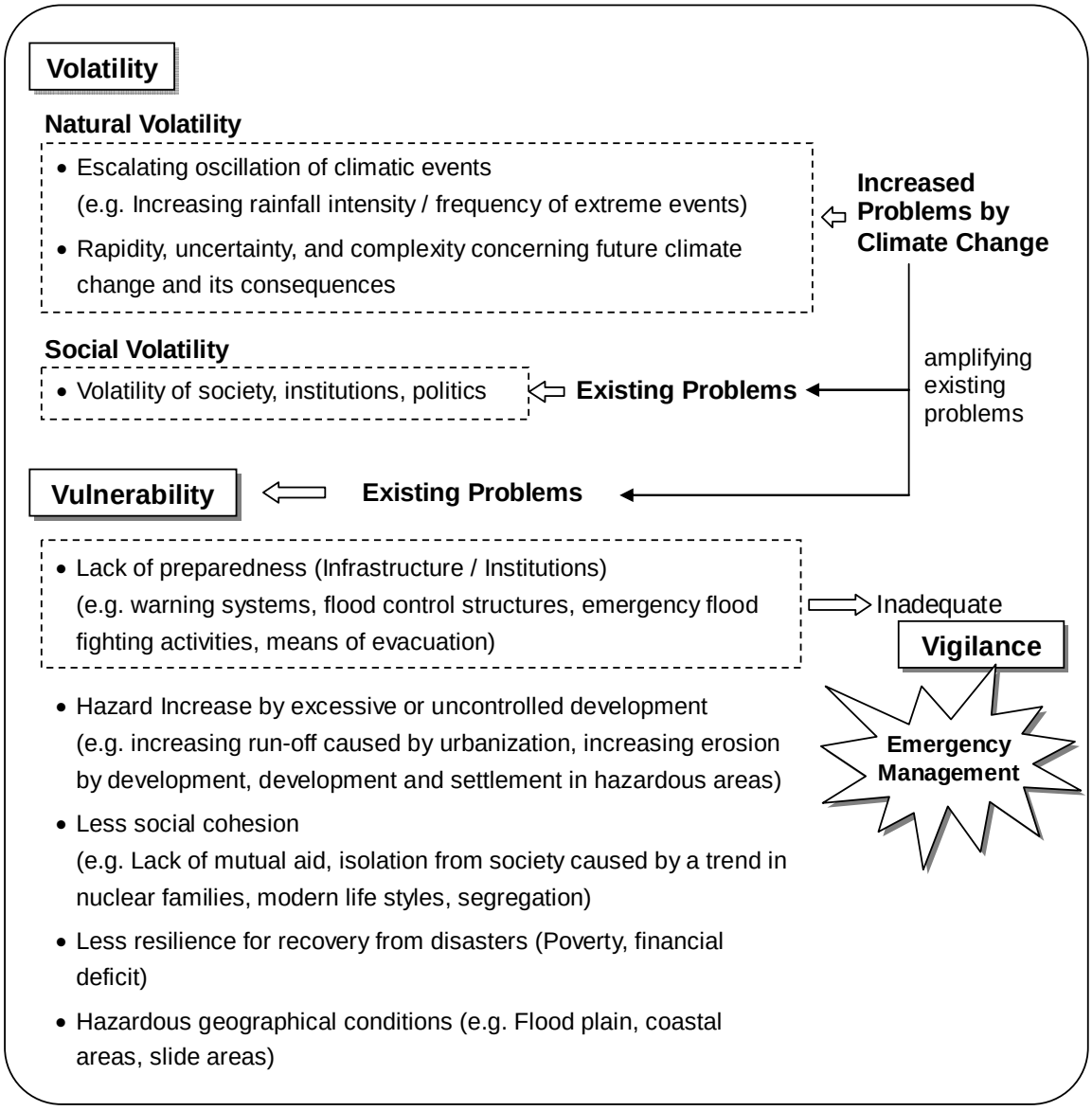

Figure 1.2 Problems Associated with Flood Management under Climate Change

Volatility is divided into natural volatility and social volatility. The natural volatility is an increased problem under climate change caused by the escalating oscillation of climatic events such as increasing rainfall intensity and frequency of extreme events. Flooding is one of the extreme hydrological events, which might be increased locally under climate change. The natural volatility also includes rapidity, uncertainty (non-stationarity or non-probabilistic), and the complexity concerning future climate change and its consequences. These are the new challenges in flood management under climate change. The social volatility, which is often observed in developing countries, is volatility of society, institutions, and political situations. Adverse impacts by climate change may amplify the social volatility, e.g. growing social instability caused by increased flood damage.

Vulnerability also can be amplified by climate change. For example, safety level of flood control infrastructure would be deteriorated by sea level rise and increased rainfall intensity under climate change. Vulnerability includes a lack of preparedness of infrastructure and institutions, hazard increase by excessive or uncontrolled development, less social cohesion, less resilience for recovery from disasters, and hazardous geographical conditions.

Vigilance can be defined as emergency management, which reduces negative consequences of flooding. Namely, lack of preparedness causes inadequate vigilance.

Figure 1.3 simplifies the relationship of the ‘three Vs’.

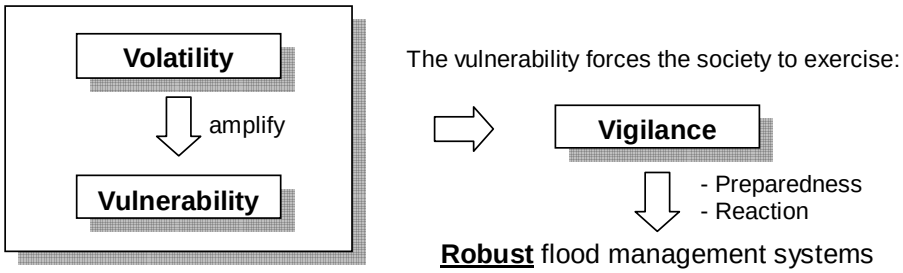

Figure 1.3 Relationship of Volatility, Vulnerability, and Vigilance (Three Vs)

As mentioned above, volatility caused by rapidity, uncertainty, and the complexity of climate change amplifies vulnerability. The vulnerability forces the society to exercise vigilance. Vigilance is the preparedness and reaction against flood threats caused by volatility and vulnerability to establish robust flood management systems.

1.3 Justification of the Research

Based on the identified problems, the research is justified by the following four reasons:

1) Urgent need to cope with flood threats under climate change

2) Paradigm shift in flood management

3) Disparities between developed and developing countries

4) Pursuit of efficiency for flood management by enhanced capacity

The research formulates capacity building methodologies for flood management under

climate change, which contribute to fulfill the above four subjects directly or indirectly. This section discusses these reasons for justification of the research more in detail.

1.3.1 The Urgent Need to Cope with Flood Threats under Climate Change

Climate change may have adverse impacts on severity of flood events by its volatility. The impacts of climate change include increasing rainfall level and intensity, and high tide and the degradation of drainage by the sea level elevation. Although the IPCC AR4 reports (Metz et al., 2007; Pachauri and Reisinger, 2007; Parry et al., 2007; Solomon et al., 2007) show these phenomena accelerating and clarify escalating fears of flood damage, the following uncertainties constitute barriers to the resolution of this problem:

- Local effects of the global climate change including magnitude and time-frame are still not precisely predictable, which often causes difficult decision-making regarding practical flood management.
- Climate change involves various policy areas: not only water resources but also energy, environment, economy and so on.
- Adaptive approaches required to cope with climate change are difficult concepts to apply to realistic financing, planning, and implementation because it is arduous to clarify urgency and cost-effectiveness.

- It becomes difficult to achieve the widely recognized goals relevant to climate change and water resources management as founded in the Kyoto Protocol[1], MDGs[2], and formulation of IWRM plans[3], which have been globally announced and agreed upon. These difficulties may cause skepticism about the validity of the rigorous goal settings and the effect of further international collaboration to cope with adverse impacts of climate change on flood management.
- Under the circumstances, flood management, taking climate change into consideration, is nascent or often fragmented and hastily formulated only to meet the recent escalation of interest extemporaneously. Or, climate change is often utilized conveniently as one of the reasons for project promotion.

1.3.2 Paradigm Shift in Flood Management

The contexts surrounding water resources management including flood management

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[1] Kyoto Protocol; Industrialized countries are imposed to reduce their collective greenhouse gas emissions by 5.2% compared to the year 1990 baseline over the 2008 to 2012 period. National limitations range from 8% reductions for the European Union and some others to 7% for the United States (not ratified), 6% for Japan, 0% for Russia, China, and India.

[2] Millennium Development Goals (MDGs); Target 10 of MDGs is "Halve, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation".

[3] Integrated Water Resources Management (IWRM) plans; The Plans of Implementation adopted at the World Summit on Sustainable Development in 2002 called for countries to "develop Integrated Water Resources Management and Water Efficiency Plans by 2005".

have been shifting globally. The paradigm shift is followed by progress of democratization, diversification of people's sense of values, rapidly growing population and associated excessive development, concentration of the population into urban areas, more emphasis on environmental conservation, worldwide financial deterioration, and other increasing complexities.

Major events influenced by the paradigm shift include the establishment of the U.S. Environmental Protection Agency (EPA) in 1970, the adoption of the European Water Framework Directive[4] (WFD) in 2000, and the adoption of the United Nation's Millennium Development Goals (MDGs) in 2001. Simultaneously, they have been also facilitating the paradigm shift in water resources management in practice including flood management. The policies and activities of the EPA have been impacting implementation of water resources projects not only in the U.S., but also environmental policies in a number of other countries. The key objective of WFD is to achieve the "good water status" for all European waters by 2015. Public participation is one of the main instruments addressed by the directive in order to achieve this objective. MDGs have been some of the most important criteria for project implementation relevant to water resources in developing countries since the adoption. **Figure 1.4** describes the paradigm shift in flood management.

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[4] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, published in the Official journal of the EC on 22 December 2000.

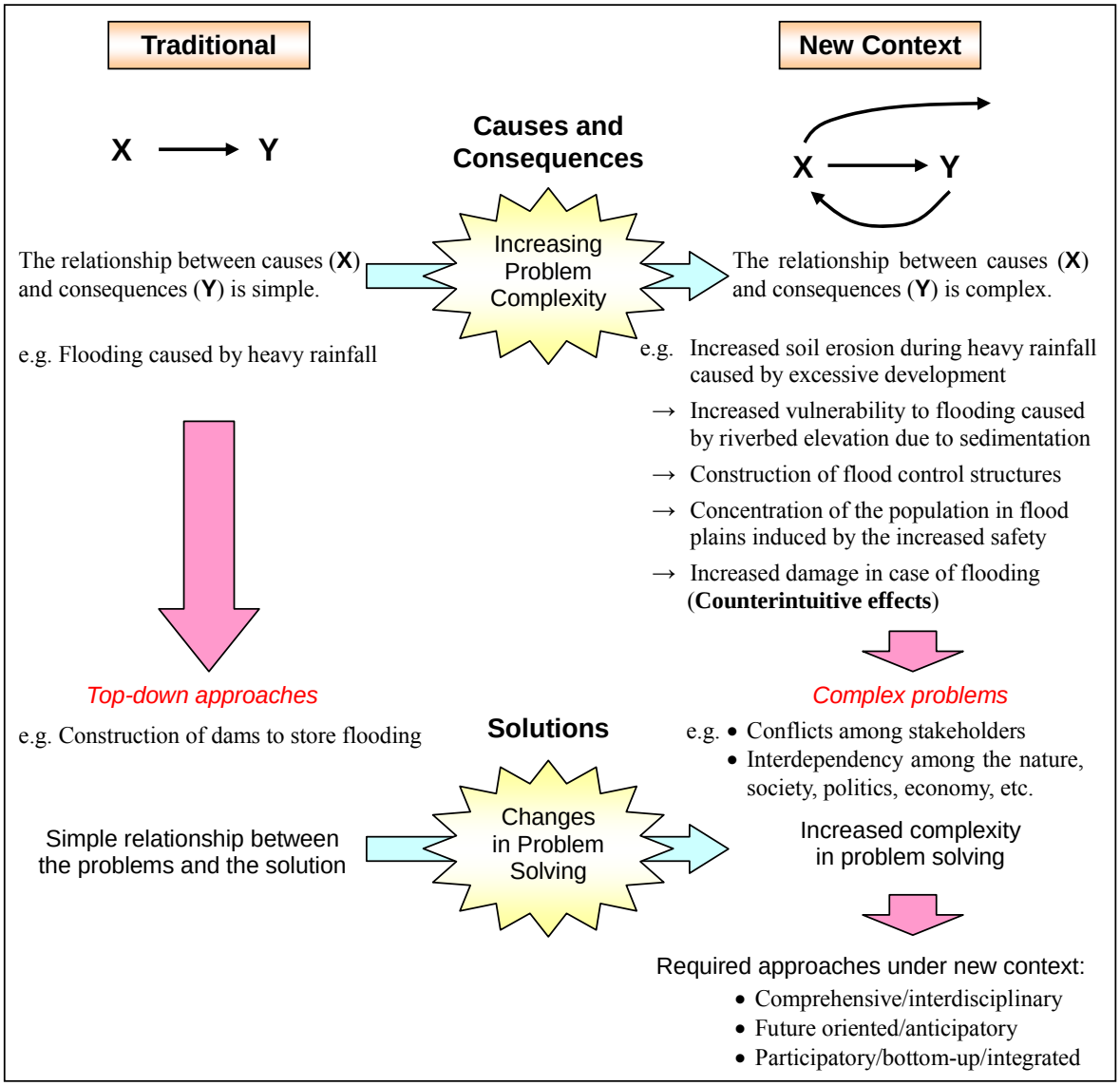


Figure 1.4 Paradigm Shift in Flood Management

The traditional flood management shows the simple causes and consequences of flooding and the resulting simple solutions. The traditional approach was workable because of the reasons including the smaller population in flood plains, more despotic administration, and lack of awareness among local population compared to the present day. The flood management means

were determined by top-down approaches mainly relying on structural measures. The approach has been effective for rapid implementation of flood management means to meet the paradigm in the past. However, the approach has been causing negative impacts on natural and social environments with the passage of time.

The problems have been complicated and intertwined following the above mentioned changes in society. So-called counterintuitive effects, for example, constructions of flood control structure induces more concentration of urban populations and causes more sever flood damage in case of levee breaks, may occur against the intended effects of flood management measures. Therefore, system analysis is required to maximize positive effects of flood management measures. That is to say, required approaches under the new context are more comprehensive, interdisciplinary, future oriented, anticipatory, participatory, bottom-up, and integrated.

Park summarized approaches to meet the paradigm shift in water resources management (Park, 2004) as shown in **Table 1.1** based on review of relevant literature (Gleick, 2000; Schultz, 1998; Serageldin, 1995; WCD, 2000; WWC, 2000a; b). However, the approaches are still often considered as time and cost consuming. In addition, insufficient resources including lack of guidelines, institutions, and human resources have been constraints to the new approaches. Increased flood risks under climate change added to the paradigm shift may complicate the problems and solutions.

Table 1.1 Approaches to Meet the Paradigm Shift

Sources	Approaches to Meet the Paradigm Shift
Serageldin (1995)	1. Long-term vision 2. Comprehensive management 3. Decentralization and stakeholder participation 4. Market and price mechanism
Schultz (1998)	1. Principles of sustainable development 2. Ecological quality 3. Consideration of macro-scale systems and effects 4. Planning in view of changes in natural and socioeconomic systems
Gleick (2000)	1. Shifting away from new water resources 2. Growing emphasis on ecological values 3. Re-emphasis on meeting basic water needs 4. Use of non-structural alternatives, application of economic principles, and extensive public participation
WWC (2000)	1. Holistic and systematic approach 2. Participatory institutional mechanisms 3. Full-cost pricing of water services 4. Institutional/technological/financial innovations 5. Governments as enablers
WCD (2000)	1. Gaining public acceptance 2. Comprehensive options assessment 3. Addressing existing dams 4. Sustaining rivers and livelihoods 5. Recognizing entitlements and sharing benefits 6. Ensuring compliance 7. Sharing rivers for peace, development, and security

Source: The elements are summarized in (Park, 2004) as "Summary of the new water paradigm components" based on review of literature including (Gleick, 2000; Schultz, 1998; Serageldin, 1995; WCD, 2000; WWC, 2000a; b).

1.3.3 Disparities between Developed and Developing Countries

Developing countries are more vulnerable to flood damage compared to developed countries because of the following reasons:

- Inundation by spilled river water or insufficient drainage of storm water often interrupts national economic activities in developing countries. Extreme climatic events caused by climate change may worsen the situation.
- Flood management infrastructure, including water storage projects, levees, and drainage facilities that may offer resilience to the adverse impacts of climate change, is still limited in developing countries. However, large-scale infrastructure development becomes difficult even in developing countries because of disputes following the recent increased awareness of both natural and social environmental issues.
- Accumulation of the hydrological and meteorological data and knowledge required to formulate local measures is often limited in developing countries.
- Implementation of both physical and institutional measures in developing countries often takes longer, due to various constraints including financial deficit and lack of administrative experience.
- Flood damage could be increased because of insufficient information due to lack of communication devices, less communication between stakeholders, and lack of

information disclosure caused by less democratic governance.

Climate change may widen the disparities between developed and developing countries unless measures to mitigate the vulnerabilities are implemented in a timely fashion.

1.3.4 Pursuit of Efficiency for Flood Management by Enhanced Capacity

Thorough justifications are required to formulate practical and rational flood management plans under climate change. Moreover, coordination of stakeholders throughout the project cycle (**Figure 1.5**) is indispensable for the smooth and steady implementation of flood management means. There is a trade-off between these requirements and the urgency to cope with flood risks. Therefore, pursuit of efficiency for flood management is vital.

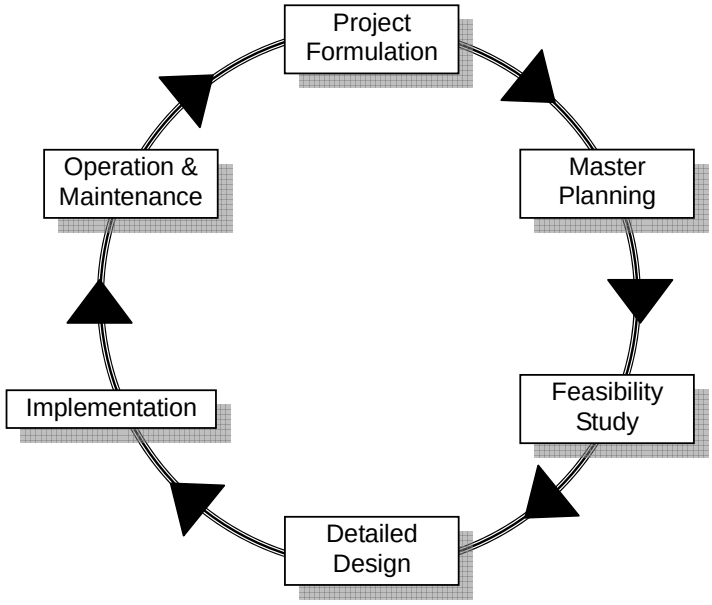


Figure 1.5 Project Cycle of Flood Management

The adequate capacity of organizations and individuals is essential to pursue effective and efficient flood management. The outcomes of the organizational and individual activities are determined by knowledge and skills multiplied by actions or abilities of agencies and human resources engaging in flood management. Namely, the outcomes are expressed as a function of the KSAs (Knowledge, Skills, and Abilities) as described in **Figure 1.6**. In other words, all of the variables, which measure the KSAs, affect the efficiency of flood management. Additionally, institutional and social capacities significantly influence the organizational and individual capacities. Under the increased uncertainty and complexity caused by climate change, pursuit of efficiency for flood management by enhanced capacity is urgently required.

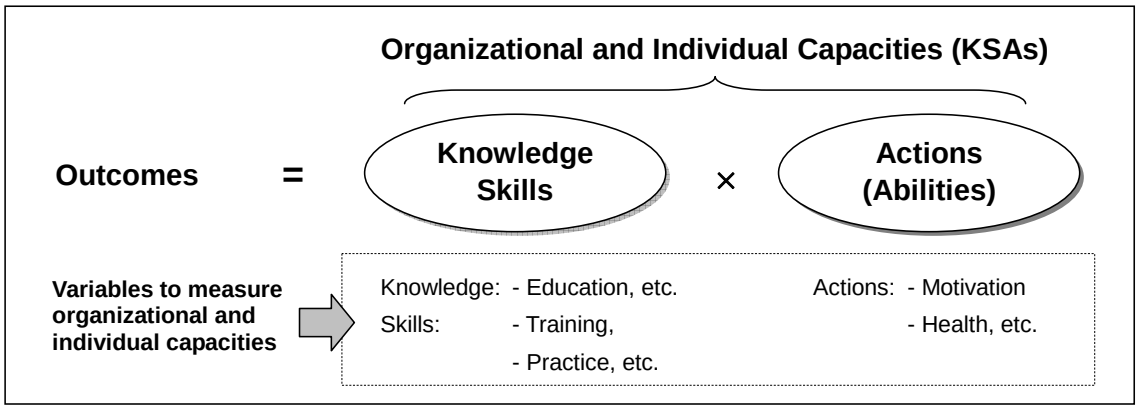


Figure 1.6 Variables to Measure Organizational and Individual Capacities

1.4 Objective of the Research

In response to the aforementioned problems and research justification, the objective of the research is to formulate and test capacity building methodologies to enhance flood management in developing countries under climate change in the context of the paradigm shift. Major research output is as follows:

A Conceptual Model of Capacity Building for Flood Management Applicable in Developing Countries

The conceptual model is an overall framework of capacity building for flood management applicable in developing countries, which includes planning, implementing, and evaluating flood management projects. The conceptual model explains how capacity affects flood management systems to reduce the negative consequences of flooding. The conceptual model consists of functions with consequences of flooding, flood severity, and elements of flood management systems as intervening variables. The conceptual model can be utilized as a tool for formulating and evaluating flood management projects.

Capacity Building Methodologies for Flood Management in Developing Countries under Climate Change

The capacity building methodologies mitigate flood risks in developing

countries under climate change through enhancing KSAs (Knowledge, Skills, and Abilities) of agencies and human resources engaging in flood management along with institutional strengthening. The methodologies consist of principles of capacity building and procedures to implement the principles. The methodologies can be also utilized to conduct and evaluate flood management projects, and to formulate the scope of works or terms of reference (TOR) of the projects for making utmost use of resources.

1.5 New Contribution of the Research

Various literature, some of which are mentioned in **Section 1.6**, point the way to adaptation methodologies of flood management under climate change. However, implementation of these concepts as well as formulation of flood management policy under climate change in the context of paradigm shift are still limited in developing countries, where national economy and social activities are more vulnerable than in developed countries.

On the other hand, capacity building in general in developing countries has been actively discussed especially by international donor agencies. However, concrete capacity building methodologies focusing on how to address flood management under climate change is still in the initial stage of its research. It is assumed due to the following reasons:

- Relationship between the elements of flood management systems and capacity building

is still unclear.

- Impacts of climate change on capacities to be developed in the context of the paradigm shift have not been clarified.

Under the circumstances, the research clarifies the above through analysis of flood management case studies. Then, the research proposes the capacity building methodologies to be applied to flood management practices. The research fills the gap between the necessity to accelerate implementation of adaptation measures under climate change and the insufficient information and activities caused by inadequate institutional, organizational, and individual capacities in developing countries.

1.6 Literature Review

1.6.1 IPCC Reports

The Intergovernmental Panel on Climate Change (IPCC) has been accumulating scientific knowledge, providing reliable information, and clarifying uncertainties regarding climate change since its founding in 1988. The panel's assessment reports, consisting of internationally-agreed-upon scientific understandings, significantly affect policymaking of international agencies and governments. The IPCC released its fourth assessment reports (AR4) in 2007 and is now working toward their fifth assessment reports (AR5) to be released in 2014.

The AR4 consists of four volumes: the three working group (WG) reports and a synthesis report. The report of WG I (Solomon et al., 2007) assesses scientific knowledge regarding climate change. It includes research and case studies regarding global and regional changes of climatic phenomena that trigger the increase of flood hazards. The report of WG II (Parry et al., 2007) assesses vulnerability of the socio-economic system and ecosystem to climate change, impacts of climate change, and adaptation measures under climate change. It assesses a number of research projects and case studies regarding vulnerabilities and measures in flood management. The report of WG III (Metz et al., 2007) assesses options for limiting greenhouse gas emissions and other mitigation measures of climate change. The options and measures introduced in the report, such as change of lifestyle and land use, affect flood management directly and indirectly. The three reports introduce needs of capacity building in institutions, organizations, and individuals to cope with climate change.

The synthesis report (Pachauri and Reisinger, 2007) assembles outcomes from the three working group reports. The synthesis report concludes that "Responses to some recent extreme events reveal higher levels of vulnerability than the TAR[5]. There is now higher confidence in the projected increases in droughts, heat waves and floods, as well as their adverse impacts" (p 65). In

[5] IPCC's Third Assessment Report in 2001.

other words, there is awareness worldwide of the increased risks, including flood risks associated with climate change. Flood risks, categorized in phenomena and anticipated consequences induced by climate change, mentioned in the synthesis report are summarized in **Table 1.2**.

Table 1.2 Flood Risks Mentioned in the IPCC AR4 Synthesis Report

No.	Phenomena	Anticipated Consequences
1	Increased heavy precipitation events and sea level rise	• Disruption of settlement, commerce, transport and societies due to flooding; pressure on urban and rural infrastructure; loss of property. • Asian and African mega-deltas, due to large populations and high exposure to sea level rise, anticipate more damage from storm surges and river flooding. • Ongoing coastal development and population growth in some areas of Australia and New Zealand exacerbate risks to population and property from sea level rise. They increase in the severity and frequency of storms and coastal flooding. • Increased risk of inland flash floods and more frequent coastal flooding and increased erosion in Europe due to storms and sea level rises.
2	Increased tropical storm activities	• Disruption by flood and high winds; withdrawal of risk coverage in vulnerable areas by private insurers; potential for population migrations; loss of property.
3	Increased morbidity and mortality associated with floods	• Morbidity and mortality due to diarrheal disease primarily associated with floods are expected to rise in East, South, and South-East Asia due to projected changes in the hydrological cycle.
4	Increased winter and spring flooding due to decreased snowpack	• Warming in western mountains in North America is projected to cause decreased snowpack and more winter and spring flooding.

Source: Summarized from "Climate Change 2007: Synthesis Report," IPCC (Pachauri and Reisinger, 2007)

Expected measures to cope with the flood risks are also summarized in the synthesis report. The structural measures include relocation, seawalls and storm surge barriers, dune reinforcement, land acquisition, creation of marshlands and wetlands as buffer zones against sea level rise and flooding, and protection of existing natural barriers. The non-structural measures include early warning systems, land-use policies, building codes, insurance, and standards and regulations that integrate climate change considerations into design.

IPCC also published "Climate Change and Water" (Bates et al., 2008), IPCC Technical Paper IV, in 2008. The report focuses especially on the issues of fresh water based on the findings of the AR4 reports but also earlier IPCC publications. The report describes that "Observational records and climate projections provide abundant evidence that freshwater resources are vulnerable and have the potential to be strongly impacted by climate change, with wide-ranging consequences for human societies and ecosystems" (p 3). The report also explains that under the current limited ability for climatic and hydrological observation and their future projection, it is difficult to predict climatic conditions and their social impact. The report points out "Decision-making needs to operate in the context of this uncertainty" (p 136). The research reviews more specific subjects in the IPCC reports in the following sections when required.

1.6.2 Other Literature

As mentioned in the previous section, the IPCC AR4 reports (Metz et al., 2007; Pachauri and Reisinger, 2007; Parry et al., 2007; Solomon et al., 2007) provide evidence that flood risks are increasing in many regions due to sea level rise, intense rainfall, and rapid snow melting induced by climate change. Following the publication of the reports, a number of researchers, agencies, and groups have been announcing research articles, recommendations, and guidelines to cope with the flood risks under climate change. Much of the literature points out needs of capacity building to deal with the new threats under climate change.

For example, Asian Development Bank (ADB), as a donor agency, explains in "Climate Change ADB Program – Strengthening Adaptation and Mitigation in Asia and Pacific" (ADB, 2009) that ADB will increase investment for its developing member countries in both "hard infrastructure" and "soft" capacity building measures beyond traditional loans and grants to support climate−friendly economic growth (p12).

The government of Bangladesh, as one of the most vulnerable developing countries to flooding, established "Bangladesh Climate Change Strategy and Action Plan 2008" (MoEF, 2008) to mitigate negative impacts of climate change. This includes a capacity building and institutional strengthening action plan to enhance the capacity of government ministries and agencies, civil society and the private sector to meet the new challenges under climate change.

The strategy and action plan was established based on the identified priority activities in the National Adaptation Programme of Action (NAPA) to climate change launched in 2005 (MoEF, 2005), which has been established in a number of least developed countries (LDCs) with supports from international agencies including UNFCCC, UNEP, UNDP, and the World Bank.

In developed countries, adaptation measures to cope with increased flood risks under climate change have been examined more concretely compared to developing countries. For example, an advisory board to the government of Japan submitted a report titled "Climate Change Adaptation Strategies to Cope with Water-related Disasters due to Global Warming" in June 2008 (Panel on Infrastructure Development, 2008). The report includes projection of climate change impacts and recommendations focusing on adaptive flood management. The report raises the capacity of human resources as one of the key constraints to implement adaptation measures under climate change (p 13).

The Dutch cabinet appointed "Delta Committee (Deltacommissie)" in 2007 to give its advice on flood protection and flood risk management in the Netherlands under climate change. The committee proposed proactive measures (Deltacommissie, 2008) to cope with flood risks. The recommendations include an overall target by 2050 and post 2050, regional targets, and political - administrative, legal, and financial set-up.

UNESCO launched "IWRM Guidelines at River Basin Level" in March 2009 (UNESCO,

2009a). Part 2-2 of the guidelines, “The Guidelines for Flood Management”, introduces flood management approaches consisting of 1) Sectoral Perspectives, 2) Key for Success, 3) IWRM Process, 4) Good Examples, and 5) Useful Tools. Although concrete adaptive flood management methodologies under climate change are not introduced, the guideline notes that the IWRM approach is required for promoting adaptation to climate change (p 26). A guideline for capacity development toward IWRM is also planned to be published as training material for practitioners (UNESCO, 2009a, Presentation).

The Associated Programme on Flood Management (APFM), a joint initiative of the World Meteorological Organization (WMO) and the Global Water Partnership (GWP), has been providing various resources to promote a concept of Integrated Flood Management (IFM) (APFM, website). For example, the APFM provides a wide range of capacity building materials including subjects concerning climate change as a self-study resource for flood managers, policy makers, and students as well as for teachers and trainers. The “HelpDesk” for IFM of APFM was launched in 2009, aiming to provide guidance to flood prone regions and countries. The HelpDesk can also be utilized to get help for capacity building for IFM in organizing advocacy workshops, awareness building campaigns, and training (HelpDesk for IFM, website).

The 5th World Water Forum (WWF5) held in March 2009 consisted of six thematic processes (WWF5, website). Out of the six themes, Theme 1 was “Global Change & Risk

Management", which included sessions regarding adaptation to climate change and disaster management. Theme 6 was "Education, Knowledge and Capacity Building," which included sessions regarding capacity building under climate change. A session paper in Theme 6 (Woman for Water Partnership et al., 2009) mentioned that "Present and future challenges facing the water sector, including climate change, will demand the mobilization of huge human and financial resources. It is not evident that these resources will in fact become available, and the shortage of human and organizational resources may be a larger problem than the availability of funds." (p 4)

RIMAX (Risk Management of Extreme Flood Events) is an inter-disciplinary research program aiming at developing and evaluating scientifically relevant methods and instruments for modern flood risk management including flood management under climate change. The report (Petersen, 2009) introduces the outcomes of the research categorized into forecasting and warning, preparedness of defenses, disaster management, and damage assessment and social impact as guidelines to be applied to flood management practices in developing countries.

Multilateral and bilateral donor agencies have been publishing guidelines for capacity building (e.g. GTZ-SfDM, 2005), capacity development (e.g. ADB, 2007; JICA, 2006a; Sida, 2000), and capacity assessment (e.g. JICA, 2008; UNDP, 2007) aiming at enhancing their aid efficiency. The definition of the terms of "capacity building" and "capacity development" has been discussed beginning from UNDP to a number of donor agencies until the present. There are

discussions that “capacity development” is a wider and more integrated or comprehensive concept than “capacity building” (e.g. JICA, 2006a; Lopes and Theisohn, 2003; UNDP, 2009). However, there are many cases that these terms are utilized without clear distinction as a matter of practice. In general, capacity building or capacity development involves institutional, organizational, and individual or human capacity building.

There are websites that have been accumulating and providing tools, archives, and case studies for capacity building in developing countries. For example, Capacity.org provides resources for practitioners and policy makers who work on capacity building in international cooperation (Capacity.org, website). Capacity.org is jointly published by European Centre for Development Policy Management (ECDPM), SNV Netherlands Development Organisation, and UNDP. Cap-Net is an international network for capacity building in IWRM, which is coordinated by UNDP. Cap-Net provides capacity building resources including subjects relevant to adaptation to climate change (Cap-Net, website). These websites can be utilized as important resources for promoting capacity building in developing countries.

1.7 Research Framework

The research explores how to alleviate flood risks caused by volatility and vulnerability under climate change in the context of the paradigm shift, and how to achieve sound economic

growth in developing countries with a focus on capacity building.

First, the research establishes a conceptual model, which is applicable to broad flood management systems, by identifying how capacity building improves effectiveness of flood management. The conceptual model is an overall framework of capacity building for flood management in developing countries which includes planning, implementing, and evaluating flood management projects. The conceptual model explains how capacity affects the flood management systems to reduce negative consequences of flooding.

Second, the research formulates and tests capacity building methodologies for enhanced flood management under climate change by applying the conceptual model to case studies. The capacity building methodologies consist of principles of capacity building and procedures to implement the principles. The principles show the fundamentals of decision-making for capacity building for flood management under climate change. The methodologies explain how to mitigate flood risks in developing countries under climate change. The methodologies describe the procedure for enhancing KSAs (Knowledge, Skills, Abilities) of organizations and individuals engaging in flood management along with required institutional arrangements.

To formulate effective capacity building methodologies, the research develops a solution strategy by analyzing past case studies. The research sets up three hypotheses described in **Section 1.8** to respectively establish the conceptual model, formulate the capacity building

methodologies, and test the methodologies. The research consists of the three steps described in **Section 1.9**, which test each hypothesis by analyzing the case studies.

1.8 Research Hypotheses

The following three hypotheses are established to test applicability and effectiveness of the research output, i.e. a conceptual model of capacity building for flood management applicable in developing countries, and the capacity building methodologies for flood management in developing countries under climate change.

Hypothesis 1: Applicability of a Conceptual Model of Capacity Building

If we apply a conceptual model of capacity building for flood management, we can readily evaluate flood severity, consequences of flooding, and their relationship with flood management systems since the conceptual model is supported among extensive stakeholders.

Hypothesis 1 is to verify validity of the conceptual model. The research tests the hypothesis by clarifying elements of capacity building for flood management and how they work. For this purpose, the research clarifies how the different countries planned and acted for flood management by comparing case studies in Jakarta, Indonesia and the Tokai region, Japan. The conceptual model is established based on the clarification that explains how capacity affects

flood management systems. Then, the applicability of the conceptual model is tested by literature regarding disaster management and water resources management focusing on acceptability by extensive stakeholders.

Hypothesis 2: Effectiveness of the Capacity Building Methodologies

If we conduct flood management projects following the capacity building methodologies, we can decrease uncertainty in flood management under climate change since the methodologies are supported by executing and donor agencies.

Hypothesis 2 is to verify effectiveness of the capacity building methodologies. The methodologies are formulated by applying the conceptual model to case studies under existing conditions and under climate change. The case studies are flood management plans in Manila, the Philippines and the Nyando River Basin, Kenya. The research tests the hypothesis by clarifying uncertainty in flood management under climate change and verifying how application of the capacity building methodologies decreases the uncertainty. The research introduces indicators which measure a level of the uncertainty toward implementation of flood management means taking into consideration executing and donor agencies' acceptability for taking action.

Hypothesis 3: Effectiveness of the Project Outcomes by Applying the New Methodologies

If we implement flood management projects which apply the methodologies meeting Hypotheses 1 and 2, the projects will effectively mitigate the flood risks under climate change and contribute to economic development in developing countries.

Hypothesis 3 is to verify the effectiveness of the project outcomes when the new methodologies are applied to flood management under climate change. The research tests the hypothesis by speculating about the project outcomes under climate change in the same case studies applied in Hypothesis 2. The project outcomes are evaluated by five evaluation criteria (relevance, effectiveness, efficiency, impact, and sustainability) for development projects.

The methods and required data to test the hypotheses are summarized in **Table 1.3**.

Table 1.3 Hypotheses, Test Methods, and Data Required

No.	Hypotheses	Test Methods and Data Required
1	**Applicability of a Conceptual Model of Capacity Building** If we apply a conceptual model of capacity building for flood management, we can readily evaluate flood severity, consequences of flooding, and their relationship with flood management systems since the conceptual model is supported among extensive stakeholders.	• A conceptual model is established by clarifying elements of flood management and the nature of capacity building from literature and by comparing case studies in Indonesia and Japan. • The applicability of the conceptual model is tested by literature regarding disaster management and water resources management focusing on acceptability by stakeholders.
2	**Effectiveness of the Capacity Building Methodologies** If we conduct flood management projects following the capacity building methodologies, we can decrease uncertainty in flood management under climate change since the methodologies are supported by executing and donor agencies.	• Capacity building methodologies are formulated by applying the conceptual model to flood management case studies in the Philippines and Kenya. • The effectiveness of the methodologies will be tested by introducing indicators of uncertainty and taking into consideration executing and donor agencies' acceptability for taking action.
3	**Effectiveness of the Project Outcomes by Applying the New Methodologies** If we implement flood management projects which apply the methodologies meeting Hypotheses 1 and 2, the projects will effectively mitigate the flood risks under climate change and contribute to economic development in developing countries.	• The project outcomes under climate change are speculated by applying the capacity building methodologies to the case studies in the Philippines and Kenya. • The effectiveness of the project outcomes are evaluated by the five evaluation criteria of development projects (relevance, effectiveness, efficiency, impact, and sustainability).

1.9 Research Steps

The research formulates and tests capacity building methodologies for flood management in developing countries under climate change in the context of the paradigm shift. The research consists of the following three steps:

Step1: Establish a conceptual model of capacity building for flood management applicable in developing countries,

Step 2: Formulate capacity building methodologies for flood management in developing countries under climate change, and

Step 3: Test the methodologies by applying them to case studies.

Each research step corresponds to proving processes of each hypothesis mentioned in **Section 1.8**. In addition to the three research steps, further application of the formulated capacity building methodologies is proposed to apply the methodologies for flood management in practice.

Figure 1.7 summarizes the three research steps and their interactions including the hypotheses, data input, and research output. The following sections explain the research procedures concretely.

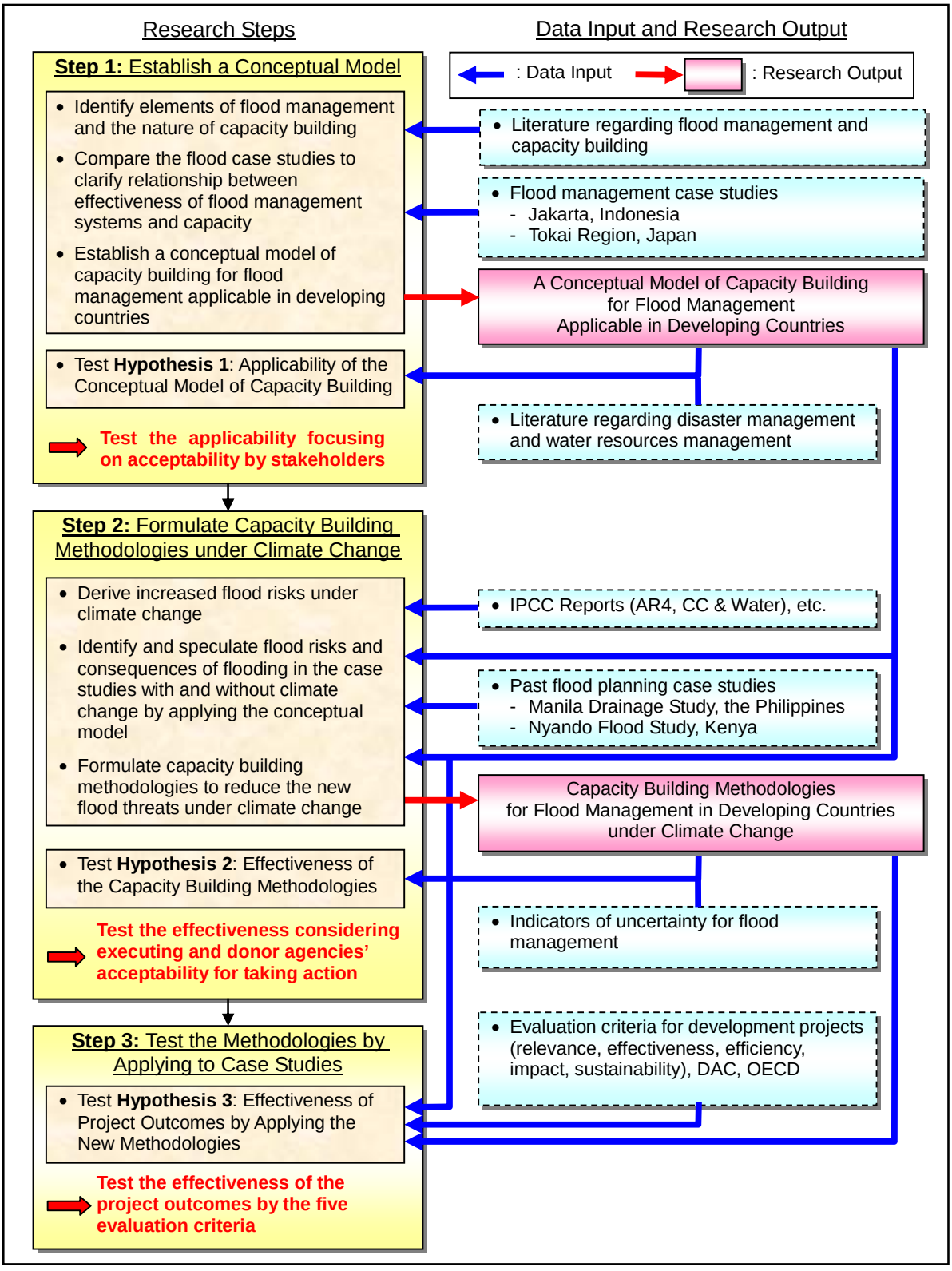


Figure 1.7 Research Steps, Data Input, and Research Output

1.9.1 Step 1: Establish a Conceptual Model of Capacity Building for Flood Management Applicable in Developing Countries

Step1 of the research establishes and evaluates a conceptual model of capacity building for flood management applicable in developing countries. The conceptual model explains how capacity affects flood management systems to reduce negative consequences of flooding. The conceptual model is applied to past flood management case studies in the following Steps 2 and 3 to examine the relationship between the flood risks and the consequences of flooding.

Figure 1.8 shows the research flow and data utilized in Step 1.

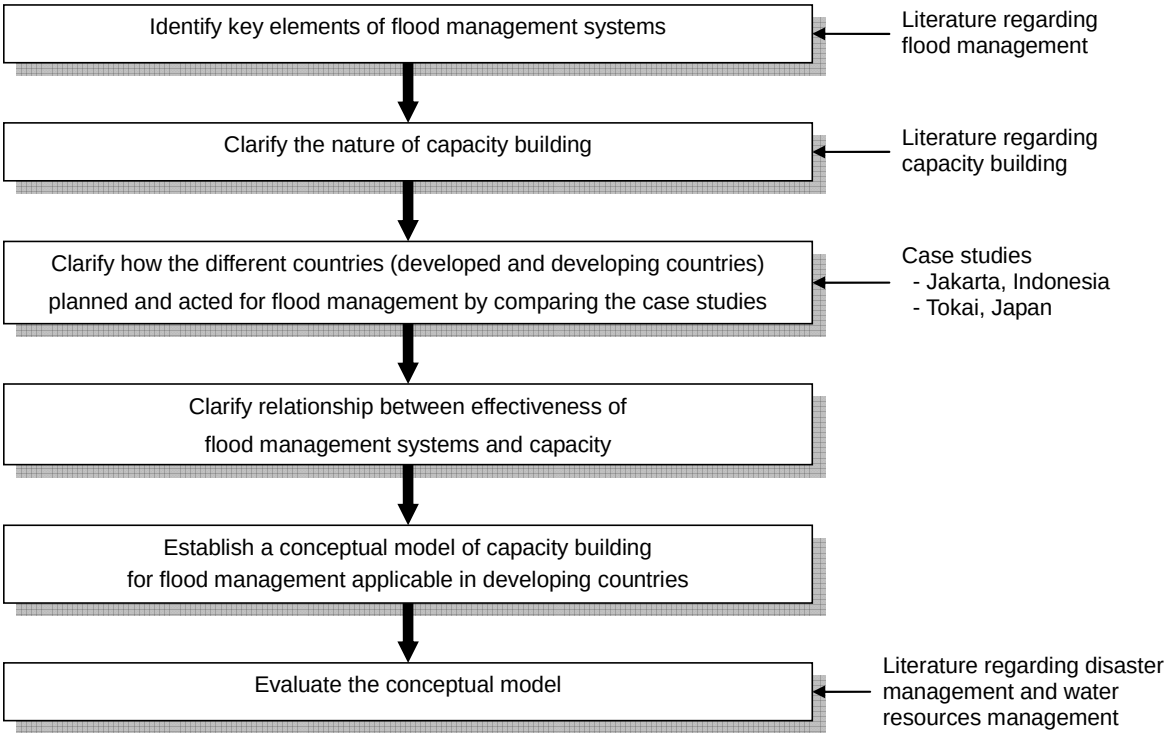


Figure 1.8 Research Flow of Step 1: Establish a Conceptual Model

First, key elements of flood management systems are identified to clarify the goals of capacity building by reviewing literature regarding flood management. The elements are categorized into:

- Objectives of flood management
- Processes of flood management
- Means to respond to flood risks and negative consequences of flooding
- Players of flood management systems and job requirements of those involved in flood management

Second, the nature of capacity building is clarified by reviewing literature regarding capacity building. This includes the following:

- Definition of capacity and capacity building
- Elements of capacity building including processes, levels, and targets of capacity building
- Performance indicators of flood management systems, which are categorized in effectiveness of institutions, effectiveness of flood management infrastructure, degree of awareness and participation by the local community, and data availability, Third,

how the different countries planned and acted for flood management is clarified by comparing two flood management case studies, i.e. Jakarta in Indonesia as a case in

developing countries and the Tokai region in Japan as a case in developed countries. In this procedure, constraints and required capacity building for flood management in developing countries are identified. Moreover, factors determining effectiveness of the flood management systems and their relationship to capacity building are analyzed. **Figure 1.9** describes how the case studies are analyzed.

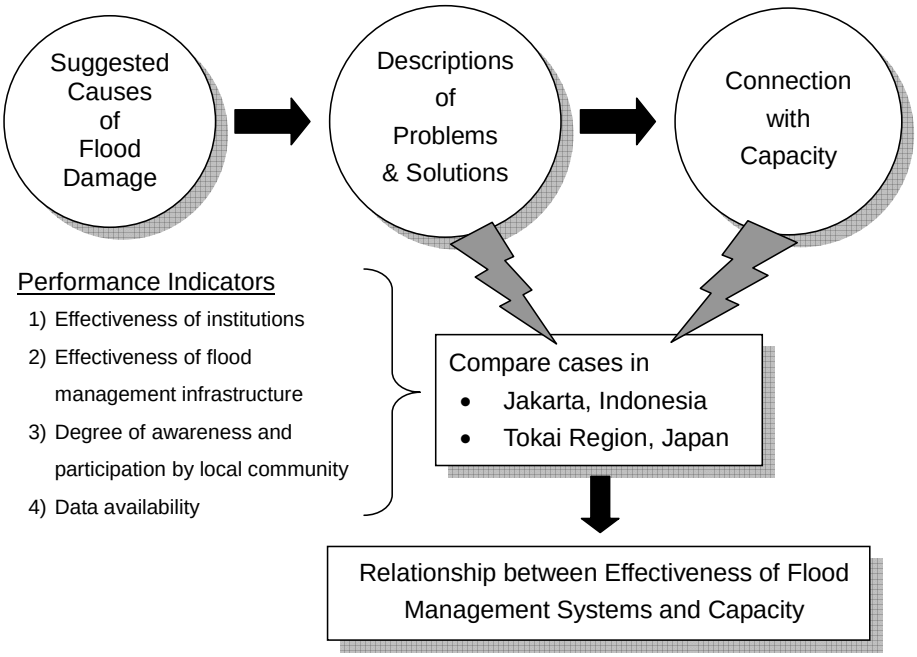


Figure 1.9 Analysis of Case Studies in Step 1

First, causes that amplified the flood damage are identified from the two case studies. Next, flood management practices in the two case studies are compared utilizing the established performance indicators of flood management systems. Based on the comparison of the two cases, factors determining effectiveness of flood management systems are clarified. Then, a conceptual

model of capacity building for flood management applicable in developing countries is established. The conceptual model consists of the following:

- A function; (Consequences of flooding) = *F* [Flood severity, Intervening variables].
- Relationship between the intervening variables and capacity building
- Performance indicators to measure effectiveness of flood management systems

The applicability of the conceptual model is evaluated by literature regarding disaster management and water resources management as follows:

- Derive core elements of disaster management and water resources management from literature, which are supported by the range of stakeholders
- Compare the core elements and the conceptual model for evaluation of acceptability of the conceptual model by the range of stakeholders.

1.9.2 Step 2: Formulate Capacity Building Methodologies for Flood Management in Developing Countries under Climate Change

Step 2 formulates capacity building methodologies for flood management in developing countries under climate change. Required capacity building under climate change is identified by applying two flood management planning case studies to the conceptual model established in Step 1. **Figure 1.10** shows the flow of the Step 2.

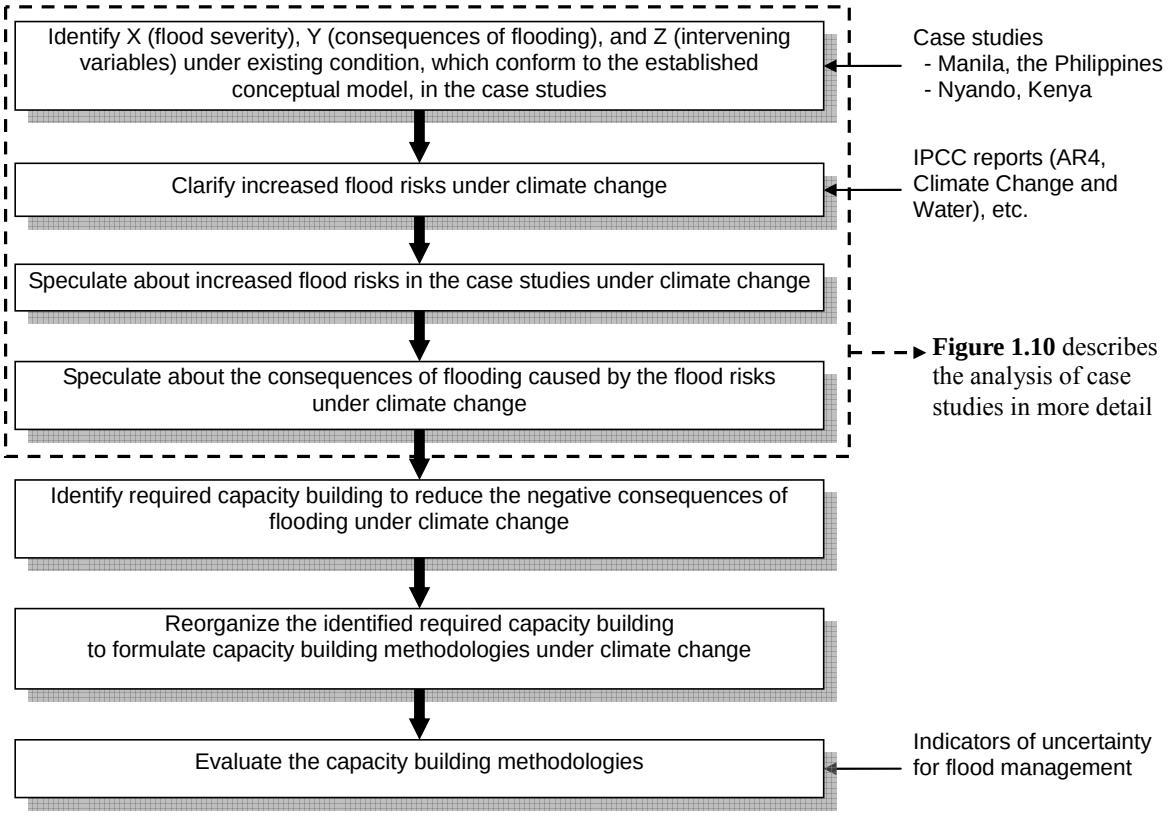


Figure 1.10 Research Flow of Step 2: Formulate Capacity Building Methodologies

First, X (flood severity), Y (consequences of flooding), and Z (intervening variables), which conform to the conceptual model, are identified from two flood management planning case studies. "The Study on Drainage Improvement in the Core Area of Metropolitan Manila" (JICA, 2005) and "The Study on Integrated Flood Management for Nyando River Basin in the Republic of Kenya" (JICA, 2009) are analyzed as the two case studies.

Second, increased flood risks focusing on volatility and amplified vulnerability under climate change are clarified from the IPCC reports and other literature. Based on the clarified

information, increased flood risks under climate change in the case studies are speculated specifically. Then, the consequences of flooding due to the increased flood risks in the case studies are also speculated.

Figure 1.11 describes the analysis of the case studies under existing conditions and under climate change in more detail.

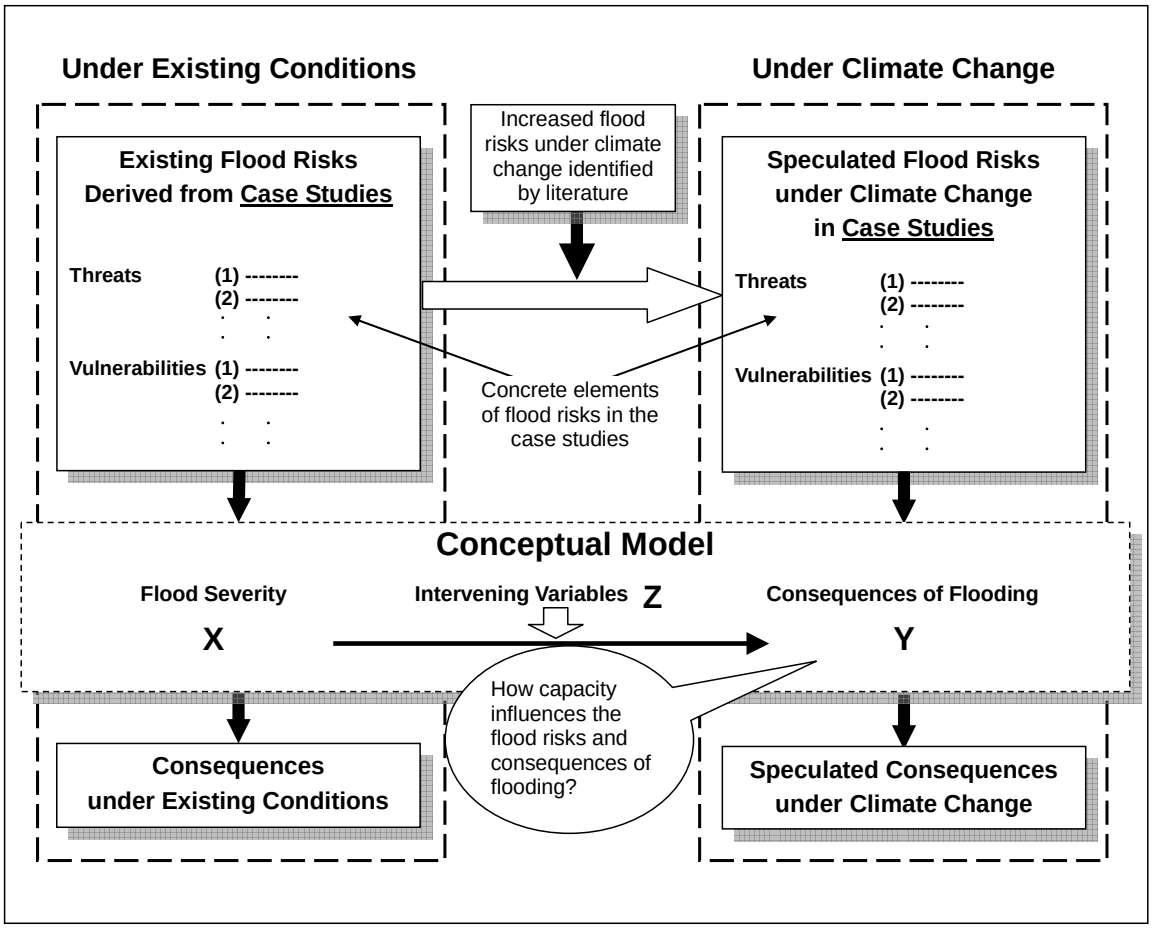


Figure 1.11 Analysis of Case Studies in Step 2

The existing flood risks derived from the case studies are categorized into threats and vulnerabilities. These threats and vulnerabilities work as variables determining X (flood severity) in the conceptual model. Y (consequences of flooding) and Z (intervening variables) under existing conditions are also derived from the case studies. Then, the relationship among X, Y, and Z, is analyzed following the contents of the conceptual model.

Next, specific increased flood risks under climate change in the case studies are speculated based on the increased flood risks identified by literature. In other words, how climate change will increase the existing threats and vulnerabilities is clarified. Moreover, the consequences of flooding under climate change are speculated assuming that Z (intervening variables) is not changed from the existing conditions. Then, required capacity building, which changes Z, to reduce the flood risks and the negative consequences of flooding under climate change is clarified. The series of speculation and clarification are performed following the components and structure of the conceptual model.

The clarified required capacity building under climate change is reorganized as capacity building methodologies. The methodologies include principles of capacity building for flood management in developing countries under climate change and procedures to implement the principles. The effectiveness of the methodologies is evaluated by verifying how application of the capacity building methodologies decreases the uncertainty associated with flood management.

The uncertainty is measured by indicators of uncertainty toward implementation of flood management means.

1.9.3 Step 3: Test the Methodologies by Applying to Case Studies

The effectiveness of the project outcomes as a result of applying the formulated new capacity building methodologies is tested with the same case studies adopted in Step 2. **Figure 1.12** summarizes the research flow of Step 3.

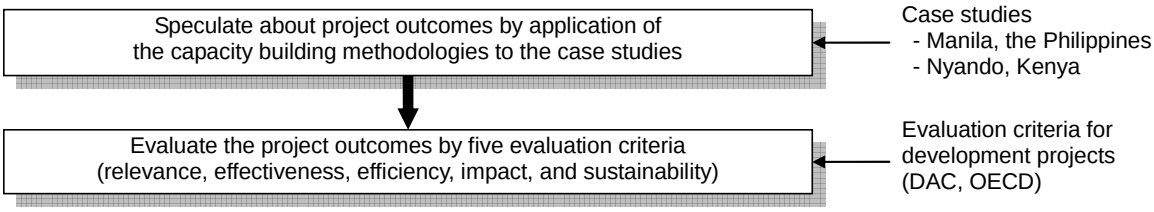


Figure 1.12 Research Flow of Step 3: Test the Capacity Building Methodologies

First, the project outcomes are speculated applying the capacity building methodologies to the case studies under climate change. The effectiveness of the project outcomes is evaluated by the five evaluation criteria of development projects (relevance, effectiveness, efficiency, impact, and sustainability), which was adopted in 1991 by the Development Assistance Committee (DAC) in the Organization for Economic Cooperation and Development (OECD) (DAC, 1991; 1998). **Table 1.4** summarizes the five evaluation criteria of development projects.

Table 1.4 Five Evaluation Criteria of Development Projects

No.	Criteria	Explanation and Notes
1	Relevance	The extent to which the objectives of a development intervention are consistent with beneficiaries' requirements, country needs, global priorities and partner's and donors' policies.
2	Effectiveness	The extent to which the development intervention's objectives were achieved, or are expected to be achieved, taking into account their relative importance.
3	Efficiency	A measure of how economically resources/inputs (funds, expertise, time, etc.) are converted to results.
4	Impact	Positive and negative, primary and secondary long-term effects produced by a development intervention, directly or indirectly, intended or unintended.
5	Sustainability	The continuation of benefits from a development intervention after major development assistance has been completed. The probability of continued long-term benefits. The resilience to risk of the net benefit flows over time.

Source: Summarized from (DAC, 1991; 1998)

CHAPTER 2

CONCEPTUAL MODEL OF CAPACITY BUILDING

FOR FLOOD MANAGEMENT APPLICABLE IN DEVELOPING COUNTRIES

2.1 Introduction

Following the procedures described in **Section 1.9.1**, this chapter establishes and tests a conceptual model of capacity building for flood management applicable in developing countries. **Section 2.2** identifies key elements of flood management to clarify targets of capacity building. **Section 2.3** clarifies the nature of capacity building which explains elements of capacity building and how they work. **Section 2.4** first identifies capacity building needs and constraints in developing countries by analyzing case studies in Jakarta, Indonesia and the Tokai region, Japan. Then, the section clarifies factors determining the relationship between effectiveness of flood management systems and capacity. **Section 2.5** describes the relationship as a conceptual model of capacity building for flood management applicable in developing countries. **Section 2.6** evaluates the applicability of the conceptual model taking into account acceptability by stakeholders.

2.2 Elements of Flood Management Systems

This section clarifies elements of flood management systems to identify targets of capacity building. This research categorizes flood management systems into four large elements, i.e. objectives, processes, means, and players as described in **Figure 2.1**.

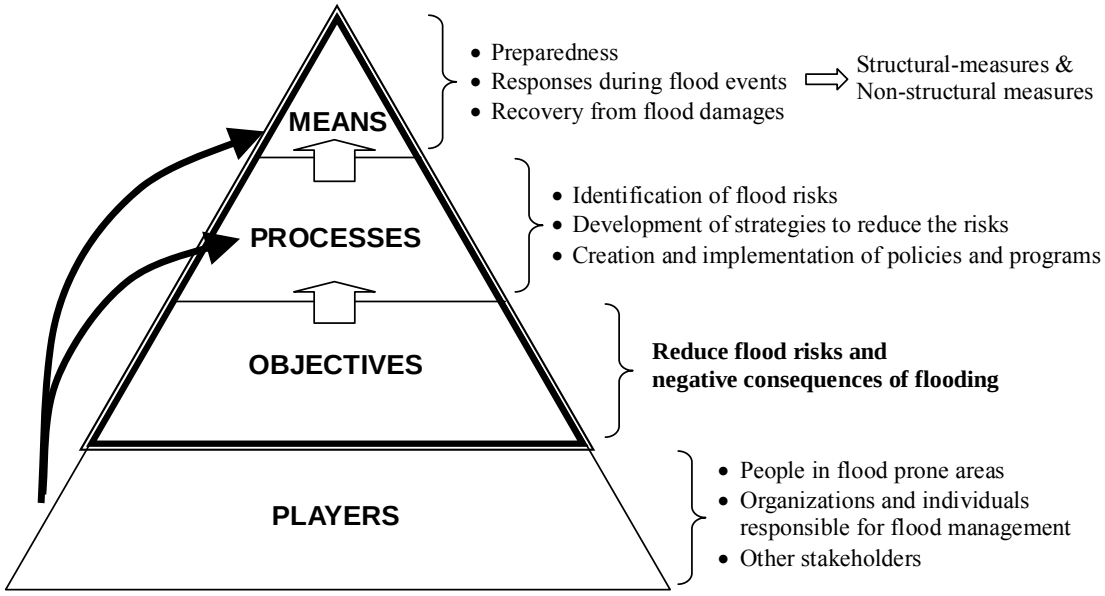


Figure 2.1 Objectives, Processes, Means, and Players of Flood Management Systems

The objectives of flood management are to reduce flood risks, and as a result, to reduce negative consequences of flooding while maximizing benefits from flood plains. Identification of the risks, namely adequate risk assessment, is the first step of flood management and it supports justification of flood management. **Section 2.2.1** describes the flood risks and the consequences of flooding to clarify the objectives of flood management.

Processes are all flood management activities including identification of flood risks, development of strategies to reduce the flood risks, and the creation and implementation of policies and programs. Outcomes of the processes largely rely on the capacity of organizations and individuals responsible for flood management. **Section 2.2.2** describes the breakdown of the processes.

Means are concrete actions to respond to flood risks and consequences of flooding. The means are categorized into three stages, i.e. preparedness (pre-flood), responses during flood events, and recovery from flood damage (post-flood). In addition, the means are categorized into structural measures and non-structural measures. The structural measures include dams, levees, and detention basins. The non-structural measures include flood warning, evacuation, land-use control, and insurance. All of these means are formulated and implemented through the "processes" mentioned above. **Section 2.2.3** describes the means for flood management.

Players are organizations or individuals that engage in flood management. The players include people who reside or work in flood prone areas as direct beneficiaries of flood management, organizations and individuals responsible for flood management such as government offices and officials, and other stakeholders including non-governmental organizations (NGOs), international donor agencies, and private sectors, which have interests or participate in decision-making of flood management. **Section 2.2.4** describes the players of flood

management systems.

2.2.1 Objectives of Flood Management

The objectives of flood management are to reduce flood risks, which are determined by threats and vulnerabilities, and as a result, to reduce negative consequences of flooding. Simultaneously, floods also have positive impacts on human activities and the natural environment, e.g. transporting fertile soil downstream and flushing pollutants and contaminants. This section reviews the flood risks and the consequences, in general, regardless of the influence of climate change, to explore the objectives of flood management.

Threats are physical phenomena such as intense rainfall and floods which are direct causes of flood damage. The threats are expressed by the probability of flood damage multiplied by the magnitude of flood damage as shown in **Figure 2.2**.

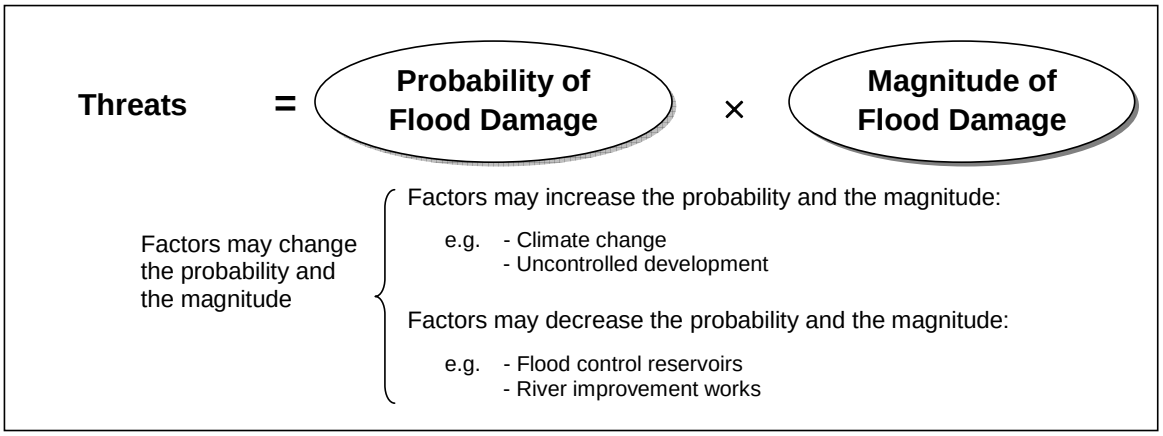


Figure 2.2 Threats as a Function of Probability and Magnitude of Flood Damage

A larger probability or magnitude of flood damage may increase the threats. Even if the probability is small, the threats can be enlarged when the magnitude of flood damage is extreme, e.g. flood damage by a dyke break in a metropolitan area, which is usually protected by high levees that respond to 200-years probable floods. This probability and magnitude fluctuate with factors such as climate change and human intervention. For example, climate change may increase probability and magnitude of flood damage regionally. Uncontrolled development such as excessive deforestation and urbanization, which prevent infiltration of storm water, also may increase the probability and magnitude of flood damage by increased run-off. In contrast, flood control reservoirs and river improvement works may decrease the probability and magnitude, if they are adequately designed and operated. Namely, the threats rely on significantly human activities in today's society, and therefore, capacity, which influences the human activities, may also influence the magnitude of the threats.

Vulnerabilities are physical and social weaknesses which increase the exposure to flood damage. **Table 2.1** shows examples of vulnerabilities to flood damage, which are categorized into the physical and social weaknesses.

Table 2.1 Vulnerabilities to Flood Damage

	Subjects	Examples
Physical Weaknesses	Lack of flood management infrastructure	• Lack of flood control facilities (reservoirs, detention basins, drainage pumps, etc.) • Inadequate flood forecasting and warning systems (telemeters, communication means, analytical problems) • Lack of evacuation facilities (emergency shelters, sign boards for evacuation, problems on evacuation routes, transportation means for evacuation)
	Hazard increase by excessive or uncontrolled development	• Increasing run-off caused by urbanization • Development and settlement in hazardous areas • Increasing erosion caused by deforestation and land development works
	Lack of emergency flood fighting activities	• Insufficient or inadequate patrol during floods • Insufficient flood fighting knowledge, skills, and material during floods
	Hazardous geographical conditions	• Flood plain • Coastal areas influenced by high tide • Slide areas
Social Weaknesses	Less social cohesion	• Lack of mutual aid •Segregation • Isolation from society caused by a trend in nuclear families • Modern life styles which have less communication with neighborhood
	Less resilience for recovery from disasters	• Difficulty in self-sustaining recovery caused by poverty and technical problems • Difficulty in rehabilitation of infrastructure caused by financial deficit and technical problems • Lack of institutions which facilitate recovery works
	Lack of knowledge, skills, and abilities	• Lack of knowledge, skills, and abilities in flood hazard, evacuation, flood fighting, and recovery caused by inadequate training and education programs
	Security problems	• Difficulty in evacuation caused by security problems (thefts during absence from homes, security problems in shelters)

The physical weaknesses include lack of flood management infrastructure, hazard increase by excessive or uncontrolled development, lack of emergency flood fighting activities, and hazardous geographical conditions. The social weaknesses include less social cohesion, less resilience for recovery from disasters, lack of knowledge, skills, and abilities, and security problems. These vulnerabilities are increased by inadequate capacity, and in contrast, they can be mitigated by enhancing capacity of organizations and individuals responsible for flood management along with appropriate institutional arrangements.

The negative consequences of flooding are caused and enlarged by these flood risks, i.e. threats and vulnerabilities. The negative consequences include interruption of economic activities, disruption of lives, and they may cause an unstable society. On the other hand, floods as natural phenomena also have positive impacts on human activities and environmental conservation, although the research focuses mainly on how to mitigate the negative impacts. The APFM report (APFM, 2006b) illustrates beneficial aspects of flooding in recharging water resources, agriculture, fishery, and rejuvenation of the river ecosystem as summarized in **Table 2.2**.

Therefore, the objectives of flood management are to minimize the negative consequences of flooding by reducing the flood risks, i.e. threats and vulnerabilities, while maximizing the benefits from flood plains. That is to say, adequate flood management contributes to sound economic development and environmental conservation.

Table 2.2 Beneficial Aspects of Floods

Beneficial Aspects	Examples
Recharging water sources	• Recharge groundwater • Restock man-made ponds and reservoirs
Agriculture	• Provide nutrients and sediments on flood plains
Fishery	• Provide ecological trigger for spawning and migration
Rejuvenation of the river ecosystem	• Provide seasonal variability and variable sediment • Wash down pollutants and contaminants caused by the intensive use of pesticides and fertilizers • Flush out organic substances brought by untreated drainage water from farmlands, stockyards, factories and domestic use

Source: Summarized from "Social Aspects and Stakeholder Involvement in Integrated Flood Management" (p 6-7) (APFM, 2006b)

2.2.2 Processes of Flood Management

"Guidelines for Reducing Flood Losses" (UNDESA et al., 2002) mentions that "A change to proactive management of natural disasters requires an identification of the risk, the development of strategies to reduce the risk, and the creation of policies and programmes to put these strategies into effect" (p 24). These three steps are considered a planning stage of flood management. The three steps along with an implementation stage of the created policies and programs, i.e. "means" of flood management, are "processes" of flood management as described in **Figure 2.3**. The figure shows the position of the "processes" within the four elements of flood management, i.e. objective, processes, means, and players.

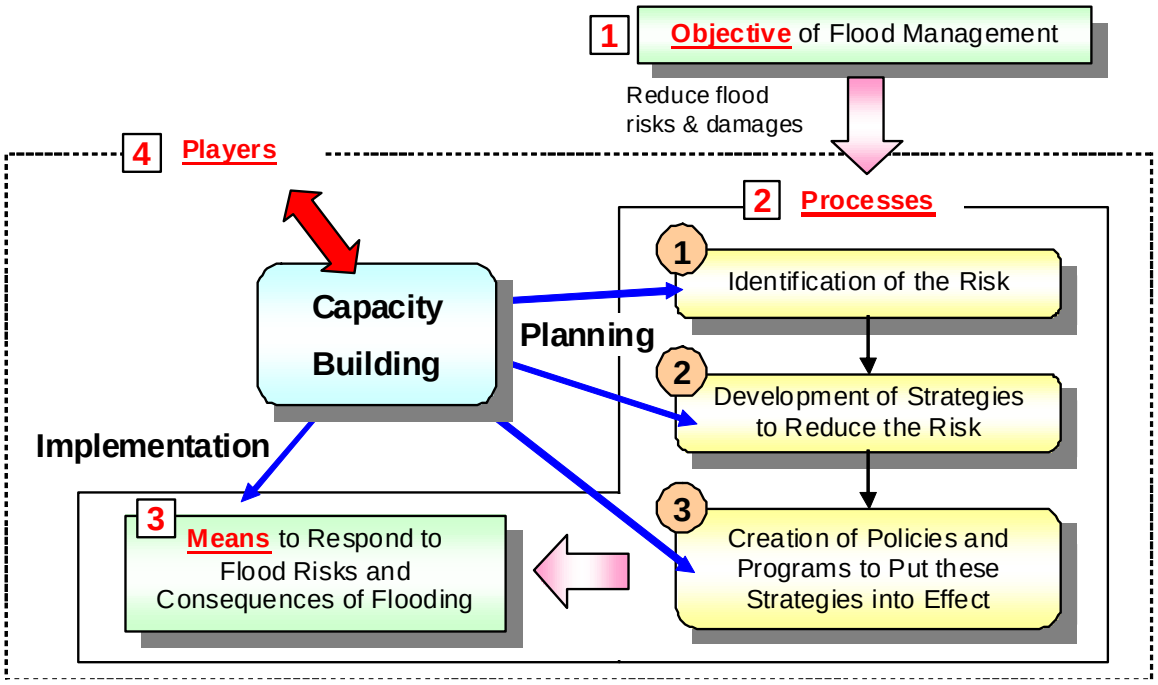


Figure 2.3 Processes within the Four Elements of Flood Management

Players of the processes are targets of capacity building. At the same time, capacity of the players is developed through the planning and implementation stages of the processes. **Table 2.3** summarizes required tasks during the processes of flood management. First, data collection and analysis are required to identify the risks. Second, flood management alternatives which reduce the identified risks are created and prioritized. Third, detailed designs of priority infrastructure and institutions are performed. Then, the infrastructure is constructed and operated, and the institutions are put into effect. Outcomes of these processes are highly dependent on capacity of organizations and human resources responsible for flood management.

Table 2.3 Required Tasks for the Processes of Flood Management

Stages	Steps	Required Tasks
Planning	Identification of the risk	• Data collection • Data analysis
	Development of strategies to reduce the risk	• Create alternatives • Prioritize the alternatives
	Creation of policies and programs to put these strategies into effect	• Detailed design of infrastructure • Detailed design of institutions
Implementation	Implementation of the created policies and programs	• Construction and operation of infrastructure • Enforcement of institutions

2.2.3 Means to Respond to Flood Risks and Negative Consequences of Flooding

The means to respond to the flood risks and the negative consequences of flooding have been developed along the history of human beings. However, the means vary depending on times, locations, and natural and social environment. The means have been selected by various factors, including available finance and technology, political situations, and local culture.

Table 2.4 shows the major means which are commonly adopted to respond to flood risks and the negative consequences of flooding. The means are categorized into three stages, i.e. preparedness (pre-flood), responses (during flood events), and recovery from flood damage (post-flood). Moreover, the table categorizes the means into structural and non-structural measures in each stage.

Table 2.4 Means to Respond to Flood Risks and Consequences of Flooding

Stages	Structural Measures	Non-Structural Measures
Preparedness (Pre-flood)	• Flood control reservoirs • Detention Basins • Levee (including circle levee, open levee, separation levee, etc.) • Riverbed excavation • Land reclamation • Drainage pumping facilities • Storm water infiltration facilities • Flood proof buildings	• Awareness raising - Hazard mapping - Education - Flood drills - Joint planning • Land-use control • Insurance • Hydrological and meteorological monitoring • Regulations to facilitate preparedness
Responses (During flood events)	• Flood fighting - Temporary levee reinforcement (sandbagging, covering levees with waterproof sheets etc.) • Improved reservoir operation	• Patrol • Warning • Evacuation • Relief • Regulations to facilitate implementation of measures during flood events
Recovery from Flood Damage (Post-flood)	• Rehabilitation of facilities • Temporary housing	• Insurance • Mental care • Regulations to facilitate recovery

The effectiveness of the means in each stage correlates with each other. That is to say, adequate preparedness may have a positive impact on the effectiveness of the means during flood events and recovery from flood damage. For example, flood drills in the pre-flood stage may improve the effectiveness of flood fighting activities and evacuation during the flood events.

Flood insurance taken out in the pre-flood stage may cover flood damage and accelerate recovery in the post-flood stage.

In a likewise manner, the structural and non-structural measures complement each other. The structural measures always have limitations of preventable magnitude of flooding, although the limitations remain unconscious to people in highly protected areas. Following the recent continuous mega flood disasters, more unpredictable flood events due to changing climate, and also the severe fiscal situations, the significance of the non-structural measure has been given more global emphasis.

2.2.4 Players of Flood Management Systems

Players of flood management systems can be explained as "stakeholders" of flood management described in "Legal and Institutional Aspects of Integrated Flood Management" (APFM, 2006a) as follows:

"The stakeholders include not only property owners and tenants or the inhabitants of an area particularly vulnerable to flooding, but also other bodies that will have an interest in the way the decisions affecting flood management are made. If flood management is to be sustainable, it must accommodate the economic, environmental and social needs of the basin, and stakeholders reflecting these elements must have a role in the way flood management is planned and

implemented." (p 21)

Out of the players, agencies responsible for flood management and the local community, which have primary responsibility to protect their lives and properties, play a central role in flood management. The agencies responsible for flood management include the central and local governments and other agencies responsible for water resources management. The local community includes inhabitants, land owners, workers in the area, and community organizations. Other stakeholders such as NGOs, donor agencies, educational institutions, private sectors, and media also influence on decision-making of the flood management systems. **Figure 2.4** shows the major players of flood management systems.

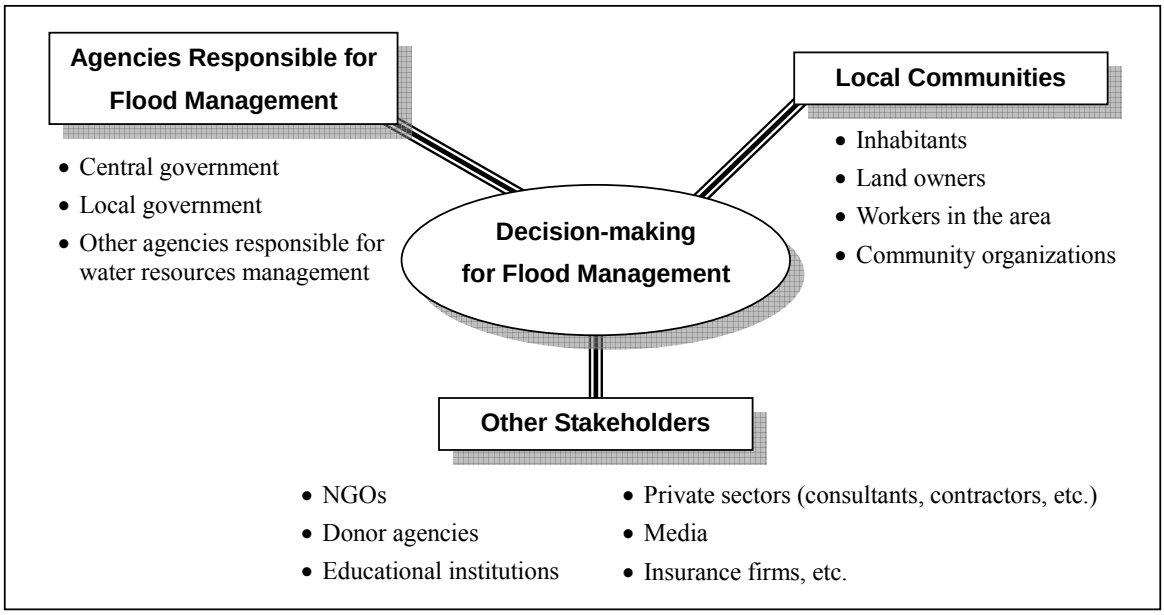


Figure 2.4 Players of Flood Management Systems

For effective flood management, activities of each player based on clear recognition of their rights and duties, and adequate capacity to implement the activities, are required. The concrete rights and duties of each player for flood management may vary depending on time and place. However, balanced job demarcation and adequate capacity to implement the tasks avoid excessive dependence upon others, and improve outcomes of flood management systems. **Table 2.5** shows major tasks of agencies responsible for flood management and the local community.

Table 2.5 Major Tasks for Flood Management

	Major Tasks for Flood Management	Examples
Agencies responsible for flood management	Policy making for flood management	• Legislation to facilitate effective flood management • Legislation for adequate land use
	Implementation of flood management policies within the legislative framework	• Planning, implementation, and operation of flood management infrastructure • Meteorological and hydrological monitoring and distribution of the information • Information disclosure regarding flood hazards • Education of the local community
Local community	Preparedness against flood disaster	• Raising awareness about flood hazards • Participation in flood management planning • Participation in flood drills • Taking out flood insurance
	Implementation of flood management duties	• Participation in operation and maintenance of flood management infrastructure • Participation in flood fighting during flood events

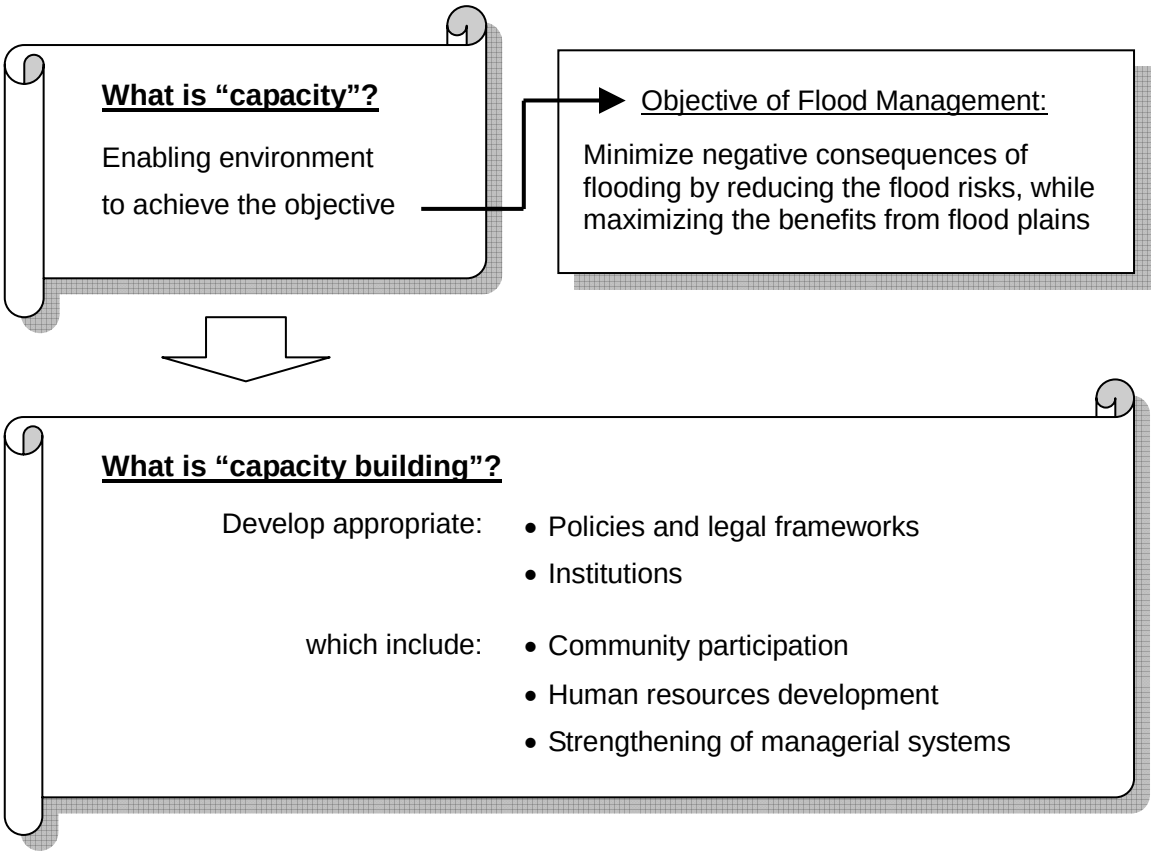
2.3 The Nature of Capacity Building

This section clarifies the nature of capacity building which explains elements of capacity and capacity building and how they work. First, **Section 2.3.1** defines what capacity and capacity building are. Second, **Section 2.3.2** explains the elements of capacity building. The section shows four "how" questions we face toward capacity building, and the targets of capacity building categorized into three levels: institutional or social, organizational, and individual. Then, **Section 2.3.3** establishes performance indicators of flood management systems to identify necessary capacity building.

2.3.1 Definition of Capacity and Capacity Building

In a formal sense, capacity building has been defined as "The creation of an enabling environment with appropriate policy and legal frameworks, institutional development, including community participation, human resources development, and strengthening of managerial systems" (Alaerts et al., 1991). The definition is followed by a series of discussions during the Symposium on "A Strategy for Water Sector Capacity Building", UNDP and the International Institute for Hydraulic and Environmental Engineering (IHE) in 1991. The definition has been referred to by a number of international agencies and researchers especially in the field of water resources (e.g. Franks, 1999; Luijendijk and Arriëns, 2009; Yillia et al., 2004).

Using this definition, it follows that the capacity for flood management can be defined as an "enabling environment" to achieve the objective of flood management by developing policies, legal frameworks, and institutions. As mentioned in **Section 2.2.1**, the objective of flood management is to minimize the negative consequences of flooding by reducing the flood risks, while maximizing the benefits from flood plains. **Figure 2.5** summarizes the definition of capacity and capacity building for flood management.



Remark: The definition of capacity building is arranged from (Alaerts et al., 1991).

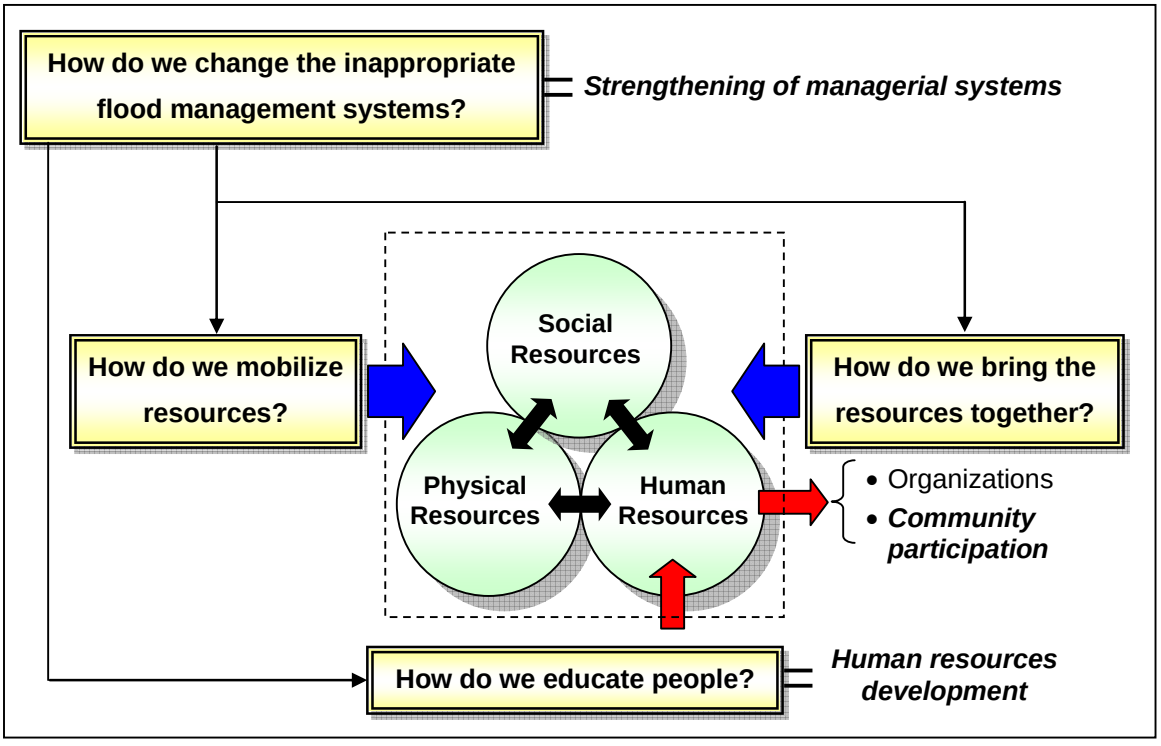
Figure 2.5 Definition of Capacity and Capacity Building for Flood Management

2.3.2 Elements of Capacity Building

As mentioned in **Section 2.3.1**, the processes of capacity building are to develop appropriate policies, legal frameworks, and institutions, which raise the following four questions:

- How do we change the inappropriate flood management systems?
- How do we mobilize resources?
- How do we bring the resources together?
- How do we educate people?

Figure 2.6 describes the relationship of the four questions.



Remarks: Subjects in ***italic*** were mentioned in **Figure 4.5** as components of the definition of capacity building by UNDP and IHE (Alaerts et al., 1991).

Figure 2.6 Four "How" Questions for Capacity Building

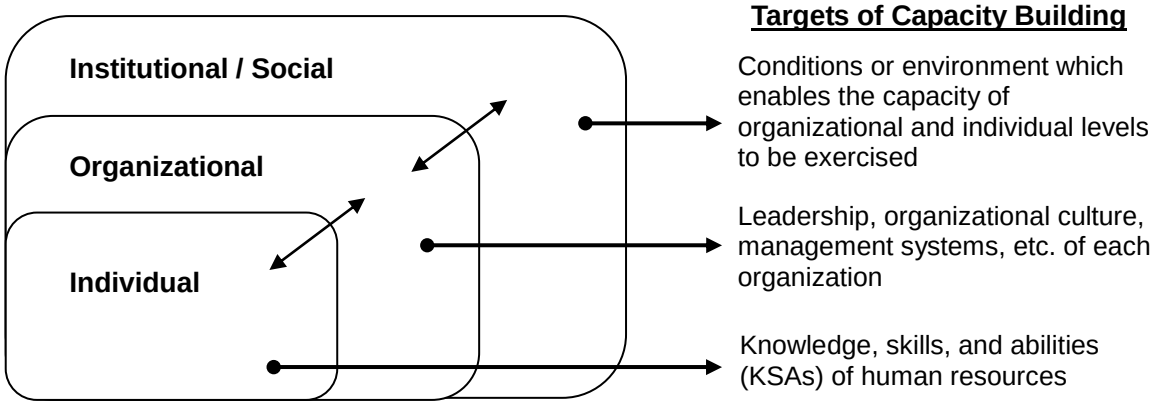
The first question is to change the inappropriate flood management systems. That is to say, strengthening of managerial systems, which was mentioned in **Figure 2.5** as a component of the definition of capacity building by UNDP and IHE (Alaerts et al., 1991). This challenge can be also said as a goal of capacity building.

The other three questions are to implement the goal of capacity building. How do we mobilize and bring together resources is a key issue for effective flood management. The resources to be mobilized are social, physical, and human in nature. Social resources include institutions and cultural elements such as customs and the society's sense of value. The physical resources include finance, material, and infrastructure. The human resources are measured by knowledge, skills, and abilities (KSAs) of people involved in flood management.

Effective flood management significantly depends on how we bring these resources together regardless of the quality of individual resources. The social, physical, and human resources influence each other on their qualities. Therefore, effective flood management requires balanced development and management of the three types of resources. Organizations and community participation, which was also mentioned in **Figure 2.5** as a component of the definition of capacity building, are methods to bring human resources together to achieve the objectives of flood management. Adequate organization and community participation will make the most use of human resources capacity.

Another question is how we educate people to improve capacity. It involves the broad processes of human resources development, with a focus on education and training.

These four questions show the three levels of capacity building: institutional or social, organizational, and individual. JICA[6] (JICA, 2004b; 2006a) illustrated the relationship of the three levels as shown in **Figure 2.7**. The figure shows that the organizational and individual capacity building is achieved within the framework of the institutional or social capacity building. The levels are interdependent, and integration among them is required to achieve goals of capacity building. For example, enhancing organizational capacity, such as effectiveness of a flood control organization, may stimulate institutional capacity improvements as the spin-off benefits impact national policy.



Source: Modified; (JICA, 2004b; 2006a)

Figure 2.7 Targets of Capacity Building in the Three Levels

[6] JICA has been mostly utilizing the term of "capacity development" instead of "capacity building" in recent years as explained in **Section 1.6.2**.

The figure also shows the targets of capacity building in each of the three levels. These are examples of resources of each level to be enhanced by capacity building. The targets of individual capacity building are KSAs of human resources. These include capacity of appropriate goal setting and motivation and action to achieve the goal. The targets of organizational capacity building are leadership, organizational culture, and management systems that include decision-making processes and a personnel system. These targets are required to achieve the given tasks of the organizations. The targets of institutional or social capacity building are to create conditions that enable the capacity of organizational and individual levels to be exercised. These include policies, legal frameworks, and institutions.

2.3.3 Performance Indicators of Flood Management Systems

Capacity assessment guidelines have been developed in the field of international cooperation to evaluate acceptability of aid programs by aid recipient agencies, to assess capacity building needs for project implementation, and to monitor and evaluate effectiveness of aid programs (e.g. Berryman et al., 1997; JICA, 2008; Lessik and Michener, 2000; UNDP, 2007). These guidelines generally recommend identification of main targets of capacity building in each level of individual, organizational, and institutional, which were mentioned in **Section 2.3.2**.

This research establishes performance indicators that interpret the all levels of

individual, organizational, and institutional capacity required for effective flood management into concrete elements of flood management in practice. These indicators are utilized in the following **Section 2.4** to analyze performance of case studies and identify deficient capacity for effective flood management. **Table 2.6** shows the performance indicators established based on the means to respond to flood risks and consequences of flooding discussed in **Section 2.2.3**.

Table 2.6 Performance Indicators of Flood Management Systems (1/2)

Category	Performance Indicators	Evaluation Criteria
(1) Effectiveness of Institutions	Institutions to facilitate preparedness	Laws and regulations to facilitate structural and non-structural measures, law enforcement
	Institutions to facilitate responses during flood	Laws and regulations for flood fighting, warning, evacuation, etc., law enforcement
	Institutions to facilitate recovery from flood damage	Laws and regulations to facilitate restoration, urgent measures, stabilize people's lives, revitalize economic activities, etc., law enforcement
	Organizations and inter-sectoral cooperation	Activities of relevant organizations, inter-sectoral cooperation and coordination
	Land use control	Laws and regulations to control new development, land acquisition in floodplain, relocation from floodplain, law enforcement
(2) Effectiveness of Flood Management Infrastructure	Flood storage facilities	Volume of flood control storage, operation and maintenance of facilities
	Levees	Dimensions of levees, maintenance of levees
	Other structural measures	Adequacy of quantity and quality of facilities, operation and maintenance of facilities
	Planning and design	Level and adequacy of planning and designing procedures

Table 2.6 Performance Indicators of Flood Management Systems (2/2)

Category	Performance Indicators	Evaluation Criteria
(3) Degree of Awareness and Participation by the Local Community	Hazard maps	Magnitude and type of target floods described in hazard maps, dissemination of hazard maps
	Joint planning	Level of participation of communities for flood management planning processes
	Information disclosure	Level of information disclosure to the public, quality of disclosed information, accessibility to the information
	Flood forecasting and warning systems (FFWS)	Contents of FFWS, quality of forecasting, accessibility to the information
	Flood fighting practices	Training, temporary levee reinforcement, patrol and warning, evacuation, relief
	Insurance	Coverage of insurance, enrollment rate
(4) Data Availability	Hydrological and meteorological data	Adequacy of number and distribution of stations, data quality, period and frequency, data accessibility
	Geographical data	Data scale, data quality, data accessibility
	Social statistical data	Variety of data, frequency of update, accessibility
	Guidelines for flood management	Quantity and quality of guidelines, regulatory standards, dissemination of guidelines
	Master plans	Existence or nonexistence of flood management master plans, update frequency, quality
	Relevant literatures	Past relevant research, accumulation of similar experiences, documentation of past experience
	Registration of infrastructure	Proper registration of flood management facilities

Figure 2.8 describes relationship between the means to respond to flood risks and consequences of flooding, which was summarized in **Table 2.4** in **Section 2.2.3**, and the performance indicators of flood management systems.

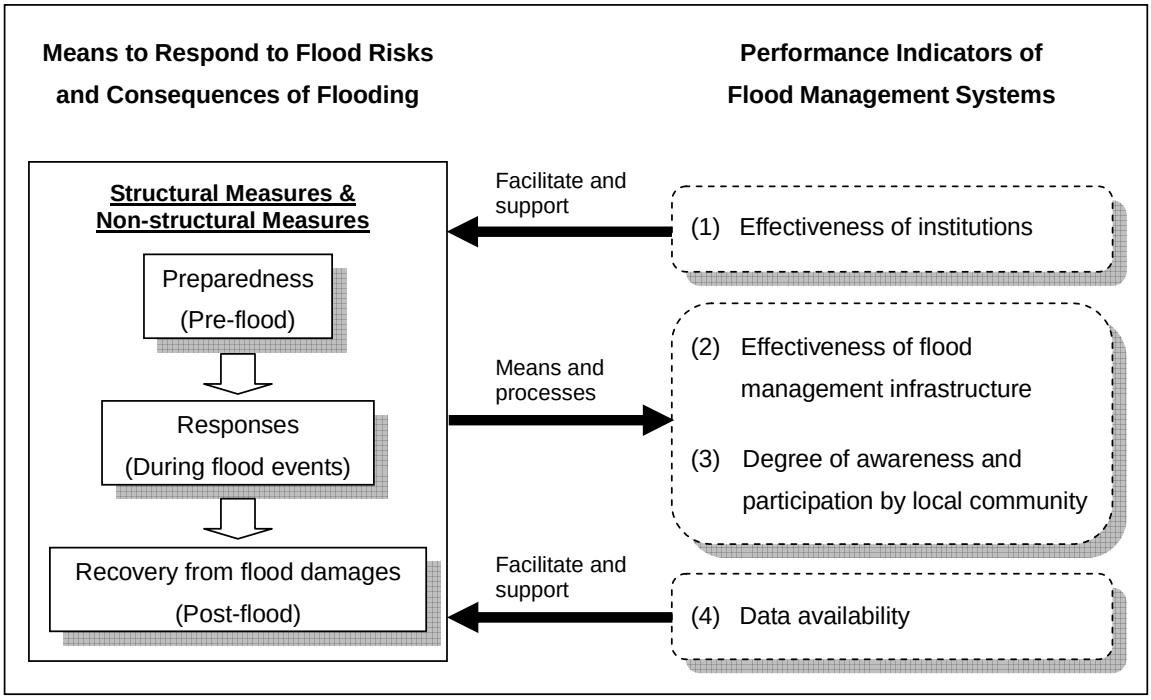


Figure 2.8 Relationship between Flood Management Means and Performance Indicators

The flood management means were classified into the chronological stages, i.e. preparedness (pre-flood), responses (during flood events), and recovery from flood damage (post-flood), and each of the stages was divided into structural and non-structural measures. On the other hand, the performance indicators are categorized in (1) Effectiveness of institutions, (2) Effectiveness of flood management infrastructure, (3) Degree of awareness and participation by the local community, and (4) Data availability. Out of the four categories, (1) and (4) facilitate the planning and implementation of flood management means and support decision-making relevant to flood management, while (2) and (3) are means and processes, which directly or indirectly

impact mitigation of flood damage.

Figure 2.9 shows the interrelationship of the performance indicators of flood management systems.

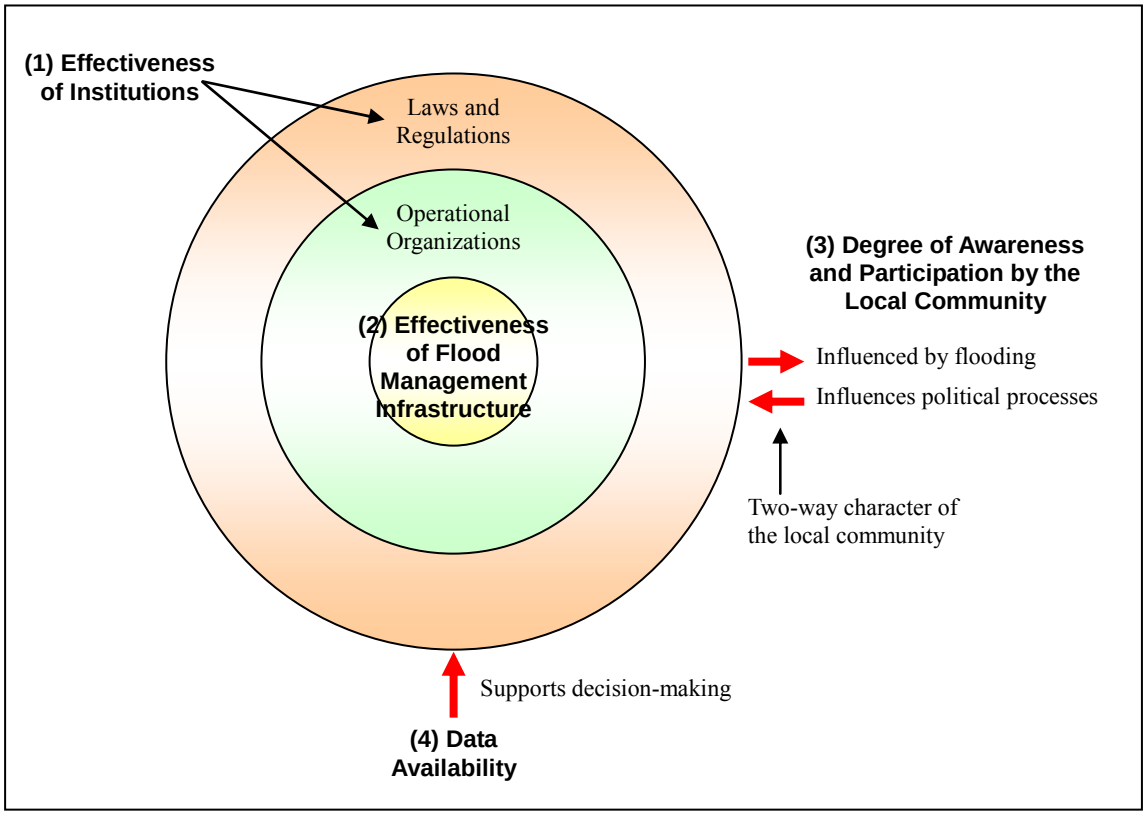


Figure 2.9 Interrelationship of the Performance Indicators of Flood Management Systems

Each of the four categories of the performance indicators consists of concrete evaluation criteria, which represent elements of flood management in practice, to measure performance of flood management systems.

Effectiveness of institutions includes indicators regarding laws, and regulations for

preparedness, responses, recovery, organizations and inter-sectoral cooperation, and land use control. Institutions are categorized into laws and regulations and operational organizations. The operational organizations perform flood management means within the framework that is stipulated by relevant laws and regulations.

Effectiveness of flood management infrastructure is measured by capacity of capital assets and their processes of planning, design, operation, and maintenance, which are also performed by operational organizations.

Degree of awareness and participation by the local community includes indicators for public information and participation in flood management processes. These indicators show the two-way character of the local community, namely that the local community is influenced by flooding, and at the same time, influences the political processes of flood management. The degree of awareness and participation by the local community are influenced by the capacity of the local community itself and by the capacity of relevant institutions and organizations.

Data availability includes indicators regarding availability of fundamental information such as meteorological, hydrological, geographical data, and social statistics, and availability of applied information such as master plans, research, and other relevant literature. Data availability support decision-making of the entire flood management systems.

2.4 Capacity Building Needs and Constraints for Flood Management in Developing Countries

This section identifies capacity building needs and constraints in developing countries and clarifies factors determining effectiveness of flood management systems by comparing two flood management case studies in the Jakarta urban area, Indonesia and the Tokai region, Japan. The location of the case studies is shown in **Figure 2.10**.

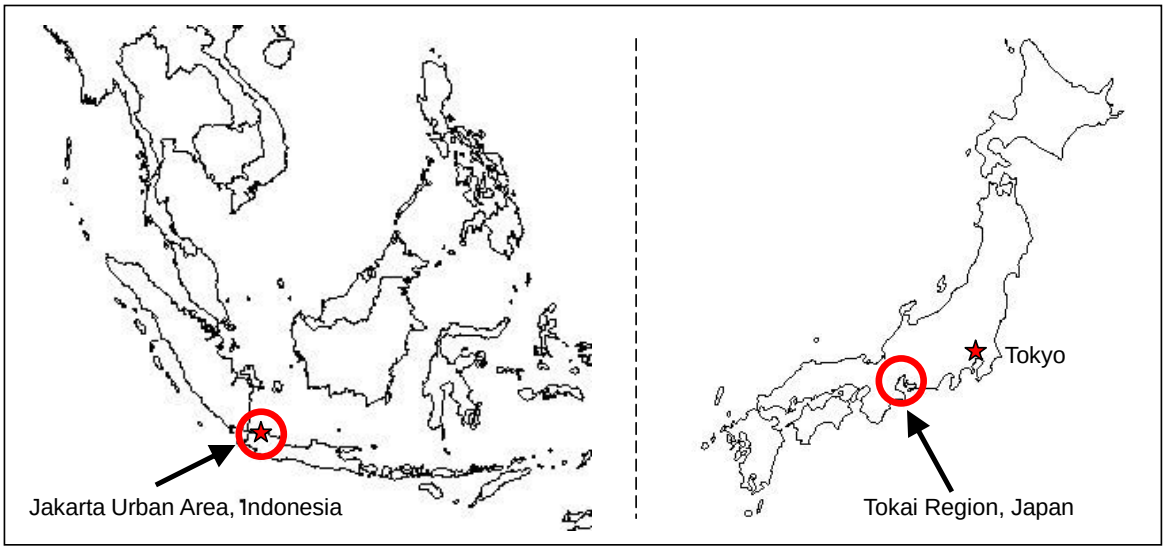


Figure 2.10 Location of the Jakarta Urban Area, Indonesia and the Tokai Region, Japan

Jakarta is a typical large city in a developing country that is vulnerable to floods due to rapid urbanization in floodplains and complex economic, social, and political problems. The Tokai region includes Nagoya city, which constitutes the third largest urban area in Japan. The

2000 flood that attacked the region had a large impact on Japanese flood management institutions and practices because of the unexpected rainfall intensity and magnitude of damage. Lessons learned and measures taken after this flood can be representative of flooding cases in developed countries.

First, **Sections 2.4.1** and **2.4.2** review flood management practices in Jakarta and Tokai. Second, **Section 2.4.3** compares the two case studies to analyze performance of flood management and identify deficient capacity for effective flood management utilizing the performance indicators established in **Section 2.3.3**. Then, **Section 2.4.4** clarifies factors determining effective flood management systems and its relationship to capacity building.

2.4.1 Flood Management in the Jakarta Urban Area, Indonesia

The Jakarta urban area with a population of 25 million suffers frequent floods. **Figure 2.11** shows major rivers and the administrative boundaries in the area. Large parts of the capital city, which is administered by the Provincial Government of Jakarta (DKI Jakarta; Daerah Khusus Ibukota Jakarta), are inundated every year during the rainy season from October or November to March or April in the next year.

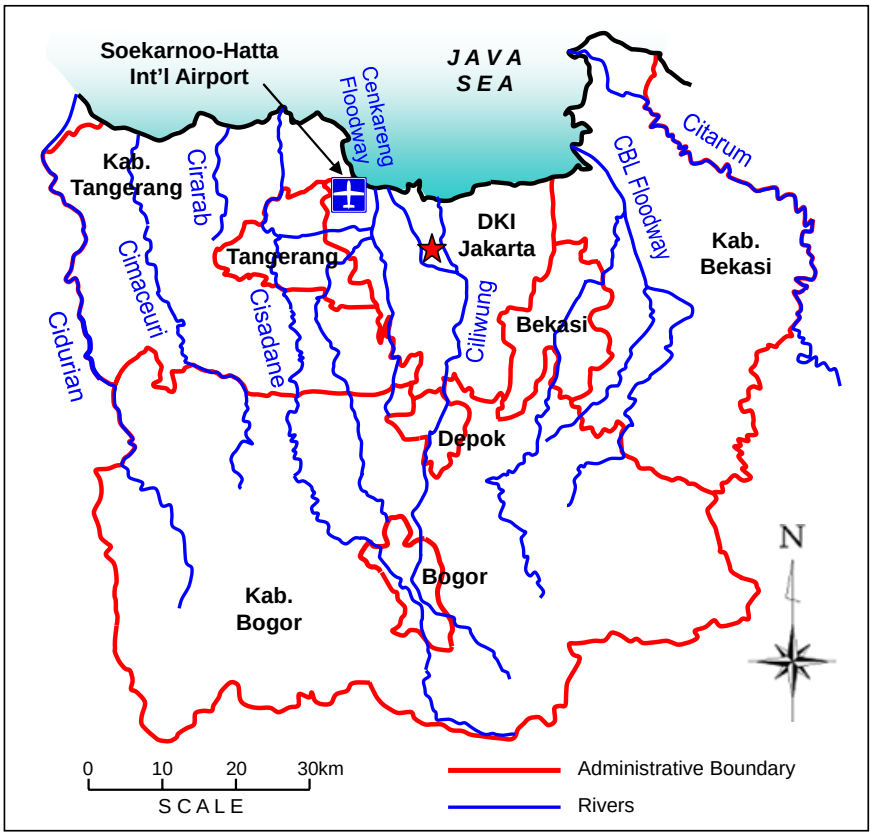


Figure 2.11 Major Rivers in the Jakarta Urban Area

As shown by **Figure 2.11**, flood problems in Jakarta are exacerbated by its location in the delta of the Ciliwung River and with 40% of its area below sea level (World Bank, 2008b). Floods were especially severe in February 2002 and February 2007. The 2002 flood caused over 30 deaths and displaced 380,000 of its inhabitants (JICA, 2006b), while the 2007 flood caused over 70 deaths and displaced 340,000 of its inhabitants (WHO, 2007). The National Development Planning Agency (Bappenas) estimated the financial losses from the 2007 flood at US$900 million (World Bank, 2007). The floods in February 2008 caused 30 deaths and shut down

Jakarta's Soekarno-Hatta International Airport for three days (World Bank, 2008b).

The flood damage in Jakarta has been increasing because of the rapid urban growth in the past few decades regardless of continuous implementation of flood management means. The flood control infrastructure was developed based on the 1973 (NEDECO, 1973), 1991 (JICA, 1991), and 1997 (JICA, 1997b) master plans. The design level was a 25-years level of protection, but a number of planned projects in the master plans have not been implemented yet due to intricate urban development issues. Therefore, the actual capacity of the flood management systems is much lower than planned. Since the master plans were established during the Soeharto regime of developmental dictatorship, implementation of the master plans has been impeded following the democratization, economic instability, and governmental reforms especially after the end of the regime in 1998.

Table 2.7 summarizes factors, which amplifies flood damage in the Jakarta urban area pointed out in articles and past studies (Caljouw et al., 2005; JICA, 1991; 1997a; b; 2004a; 2006b; Suartini, 2006; UNESCO, 2004; World Bank, 2007; 2008b). The factors include lack of flood control infrastructure, population pressure and inadequate land use control, insufficient maintenance and improper operation of facilities, lack of coordination between authorities, and inadequate emergency management. The factors listed in the table are also frequently observed in a number of other large cities in developing countries in greater or lesser degrees.

Table 2.7 Factors Amplifying Flood Damage in the Jakarta Urban Area

Factors	Remarks
Intensive rainfall and lack of infrastructure	Tropical squall during the rainy season, rapid increase of river discharge due to the short and steep watercourse, and lack of flood control and drainage facilities have been causing frequent flooding.
Population pressure	During these 30 years (1980-2010), the population of the Jakarta urban area increased more than double from 12 million to 25 million. Population pressures have been causing uncontrolled development.
Inadequate land use control, spatial planning, building regulations, and groundwater abstraction	Pressures for development converted forests and farm land in the middle reach and upstream areas and many of the city's small lakes (*waduk*) and ponds (*situ-situ*) into residential or commercial areas, leading to severe reductions in retention capacity and increases in peak discharge. The flood control systems are also adversely affected by weak enforcement of spatial plans, building regulations, and regulations on groundwater abstraction.
Insufficient maintenance and improper operation of flood control systems	The Ministry of Public Works (DPU) and DKI are required to maintain flood control infrastructure. However, budgetary allocations are substantially lower than what is needed to maintain the system. This has resulted in delay of construction of drainage branch canals and huge sediment build-up in floodways and drains, reducing protection levels responding to considerably lower level from 25-years probable floods.
Limited coverage of solid waste collection services	DKI presently collects less than 40% of its solid waste generated, where 15% to 30% of Jakarta's total waste is discarded into the city's canal. The discarded solid waste decreases capacity of rivers and drainage canals.
Lack of coordination between authorities responsible for flood management	DPU and DKI are responsible for managing Jakarta's flood control systems. DPU is responsible for rivers and floodways that cross provincial boundaries. DKI is responsible for drains and retention basins within its boundaries. However, actual job demarcation is unclear because of on-going decentralization, financial deficit, and lack of coordination.
Inadequate emergency management	Flood hazards and evacuation procedures are recognized only for limited communities. Moreover, flood warning functions only in limited areas. These cause inadequate vigilance for flood events and delay of evacuation during the floods.

Sources: Summarized from (Caljouw et al., 2005; JICA, 1991; 1997a; b; 2004a; 2006b; World Bank, 2007; 2008b).

2.4.2 Flood Management in the Tokai Region, Japan

In September 2000, a heavy rainfall, which was named the Tokai storm, caused by the autumn rain front, which was stimulated by the typhoon No.14, inundated the Tokai region centering on Nagoya city in Aichi Prefecture. Nagoya city constitutes the third largest urban area in Japan, with a population over five million. Aichi Prefecture, which had the largest flood damage by the storm, counted seven deaths, 100 injuries, and 66,000 inundated households (MLIT, 2008). The total damage was estimated at 850 billion Japanese yen (about US$9 billion) in direct economic losses (Zhai et al., 2005). **Figure 2.12** shows major rivers in Aichi Prefecture.

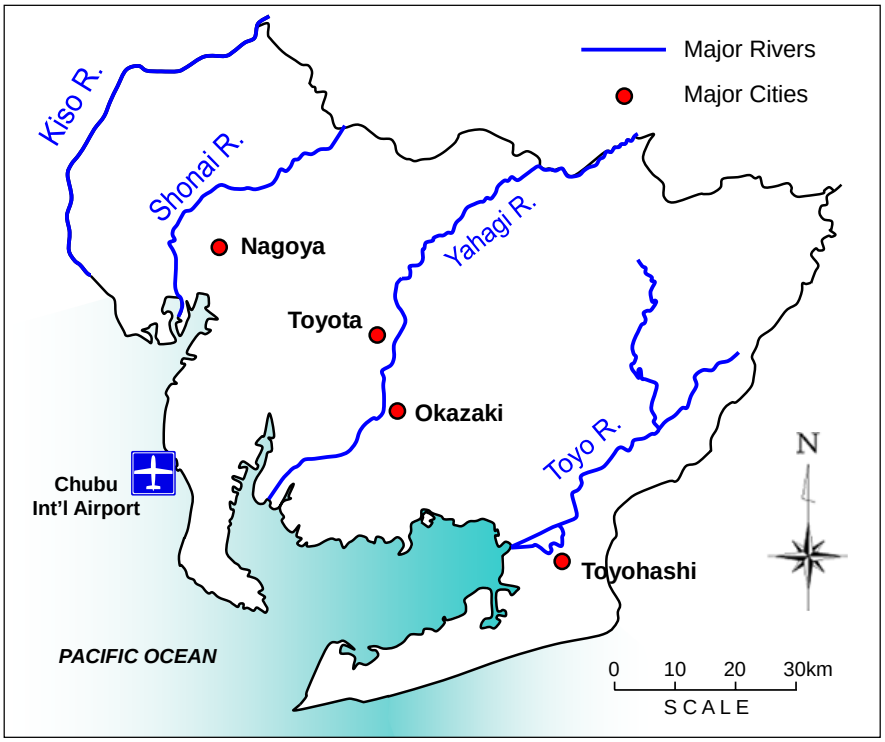
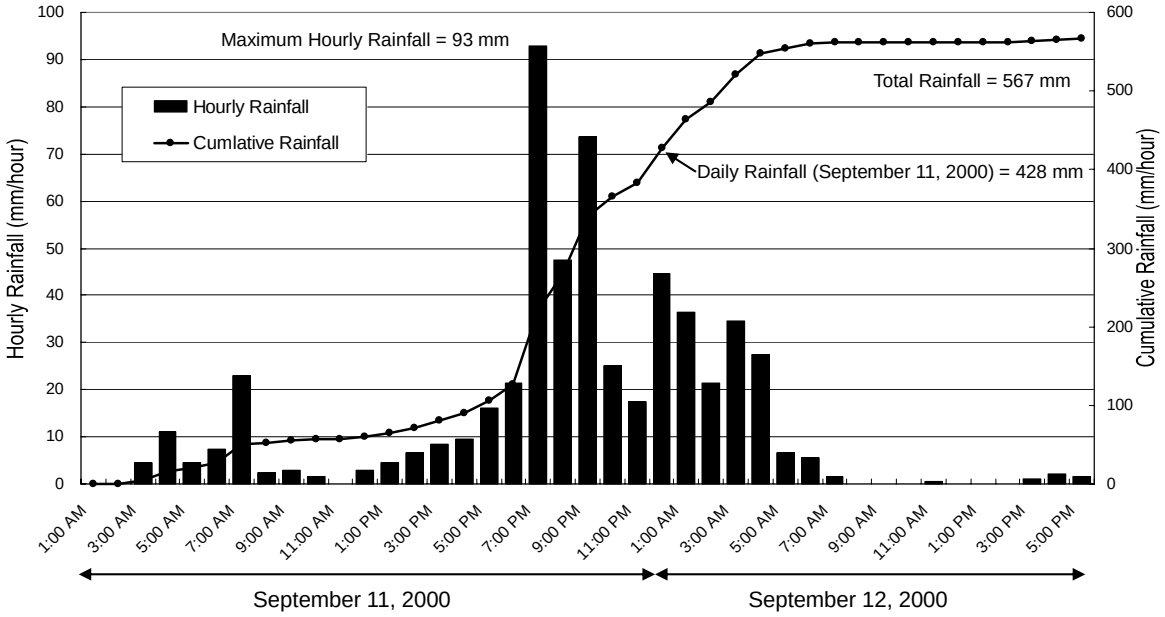


Figure 2.12 Major Rivers in Aichi Prefecture

Figure 2.13 shows hourly and cumulative rainfall records at the Nagoya weather station during the 2000 Tokai storm.



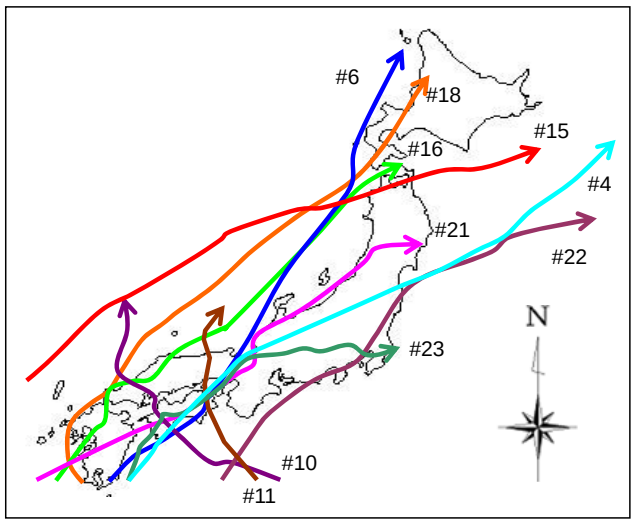
Source: Rainfall data is distributed by the Japan Meteorological Agency (JMA)

Figure 2.13 Hourly and Cumulative Rainfall in Nagoya during the 2000 Tokai Storm

In Aichi Prefecture, the rainfall started in the predawn hours on September 11, 2000. The Nagoya weather station of the Japan Meteorological Agency (JMA) recorded 93mm of hourly rainfall (the previous record was 68mm/hour) and 428mm of daily rainfall (the previous record was 217mm/day). The daily rainfall was over 500-year probable rainfall of 334mm, which was calculated based on the generalized extreme value distribution of the rainfall records from 1901 to 1999 in Nagoya (Ushiyama and Takara, 2001). The total rainfall of 567mm from September 11 until September 12 was the largest record after its starting observation in 1891.

The flood suspended railroad service including the Shinkansen bullet train, JR lines, and subway lines, and traffic through express and national arterial highways. The flood, therefore, influenced not only the Tokai region, but also the national physical distribution and economy. The Tokai storm, which was far beyond the design flood level, also revealed vulnerability, limitation of structural measures, and problems on risk management against floods.

While it caused severe damage, the Tokai storm stimulated a fundamental review of the national flood management policy. The flood fighting law, which was enacted in 1949, was amended in 2001 following a series of investigation, research, and deliberations about the causes of the flood damage. The law was amended again in 2005 following significant flood damages caused by record numbers of typhoons landed on Japan in 2004 (**Figure 2.14**).



Source: Drawn based on data from the Japan Meteorological Agency (JMA)

Figure 2.14 Typhoons Landed on Japan in 2004

Table 2.8 and **Table 2.9** summarize the flood fighting law amendments in 2001 and 2005 respectively along with identified background problems during the Tokai storm and succeeding flood events. The 2001 amendment was based on experience during the Tokai storm that the insufficient hazard information especially in small or medium scale river basins and delay of evacuation increased the flood damage. Moreover, the amendment placed an emphasis on establishing measures to mitigate flood damage from the highly utilized underground space especially in urban areas.

Table 2.8 Summary of Flood Fighting Law Amendment in 2001

No.	Identified Problems	Contents of Amendment
1	Lack of flood forecasting for rivers administered by prefectures (small and middle scale rivers)	Expanding target rivers for flood forecasting - Designation of target rivers by prefectural governors - Execution of flood forecasting by the coordination of prefectural governors and the director general of JMA
2	Lack of information about flood hazard	Publicity of hazard maps - Designation of speculated inundation areas by the minister of MLIT and prefectural governors - Publicity of speculated inundation areas and depth
3	Inadequate preparedness for evacuation	Establishing procedures to assure smooth evacuation - Including measures in the local disaster prevention plans[7] to publicize flood forecast and locations for evacuation - Establishing measures to publicize flood forecast and warning to the general public utilizing underground spaces - Publicity of the local disaster prevention plans

Source: Summarized from various sources e.g. (MLIT; Tanaka, 2002).

[7] Disaster Countermeasures Basic Law obliges municipalities to establish local disaster prevention plans.

Table 2.9 Summary of Flood Fighting Law Amendment in 2005

No.	Identified Problems	Contents of Amendment
1	Lack of hazard information for small or medium scale rivers	Expanding hazard information publicity - Expanding the target rivers to small and middle scale rivers designated by the minister of MLIT or prefectural governors - Prepare and publicize hazard maps by municipalities where expected inundation areas are included
2	Difficulty in decision-making for flood warning	Improving information transmittal for small or medium scale river basins - Setting staged water levels for easier decision-making for vigilance and evacuation - Establishing information transmittal procedures in the small or medium scale river basins
3	Inadequate flood forecast in large river basins	Improving flood forecast in large scale river basins - Forecasting inundation areas and depth in the designated large scale river basins by the minister of MLIT for effective evacuation
4	Lack of coordination with groups engaging in flood fighting activities	Establishing institutions for flood fighting cooperation - Designating public interest corporations and NPOs as flood fighting cooperation groups - Stipulating scope of works of the flood fighting cooperation groups including data collection, data distribution, and knowledge dissemination about flood fighting
5	Lack of measures to evacuate from underground facilities	Establishing evacuation plans from underground facilities - Obliging owners or administrators of underground facilities in speculated inundation areas to establish evacuation plans during flood events
6	Insufficient information transmittal to socially vulnerable groups	Improving information transmittal to social vulnerable groups - Stipulate information transmittal procedures to socially vulnerable groups such as aged people, physically-challenged people, and infants and toddlers in the local disaster prevention plans

Source: Summarized from various sources e.g. (Fujiyama, 2005; MLIT; Takahashi, 2005).

The 2005 amendment is mainly to strengthen the 2001 amendment to improve effectiveness of preparedness and emergency management to mitigate flood damage based on the experience during the series of flood events after the Tokai storm. The 2001 and 2005 amendment of the Flood Fighting Law has been contributing to improve awareness of communities regarding flood hazard.

2.4.3 Comparison of the Case Studies in Jakarta and Tokai

This section compares the two case studies in Jakarta, Indonesia and the Tokai region, Japan, which were reviewed in **Sections 2.4.1** and **2.4.2**, to clarify difference in flood management in developing and developed countries. The performance indicators of flood management systems, which were established in **Section 2.3.3**, are utilized to explain the difference. The following shows the comparison by category shown in **Table 2.6**, i.e. (1) Effectiveness of institutions, (2) Effectiveness of flood management infrastructure, (3) Degree of awareness and participation by the local community, and (4) Data availability.

(1) Effectiveness of Institutions

Table 2.10 shows comparison of effectiveness of institutions between the case studies. Generally speaking, fundamental laws and regulations for flood disaster mitigation are well

established both in Indonesia and Japan. Indonesia has the Disaster Management Law of 24/2007, the Water Law of 7/2004, and the Spatial Planning Law of 26/2007, which are for disaster management, water resources management including flood management, and land use control respectively. Japan has the Disaster Countermeasures Basic Law, the River Law, and the City Planning Law, which have similar functions of those with the Indonesian laws. The Indonesian laws are more comprehensive and democratic compared to the Japanese laws and they take into account the entire hydrological cycle and emphasize more decentralized approaches and public involvement.

However, the Japanese laws often function more effectively in practice compared to those in Indonesia. The difference in the two cases is enforcement of the laws and regulations, and availability of practical regulations, guidelines, plans, and local capacity to implement the sprit of the laws and regulations. For example, Nagoya city has a local disaster prevention plan for wind and flood disasters, which reflected lessons learned from the disasters by the 2000 Tokai storm. The plan consists of four chapters, i.e. general specifications, disaster prevention plans (pre-flood), emergency management plans (during flood), and disaster recovery plans (post-flood). Each chapter consists of detailed action plans, and they are updated frequently to maintain practicality.

Table 2.10 Comparison of Effectiveness of Institutions in Jakarta and Tokai (1/2)

Performance Indicators	Results of Evaluation and Data Sources	
	Jakarta, Indonesia	**Tokai, Japan**
Institutions to facilitate preparedness	Disaster Management Law of 24/2007 stipulates risk management particularly prevention instead of focusing just on emergency response. Strengthening of capacity in local levels is an ongoing challenge to make the institutional reform functional.	The local disaster prevention plan in Nagoya includes a chapter for preparedness. They include detailed plans for strengthening of lifelines, community awareness improvement, distributing information. (Nagoya City, 2009).
Institutions to facilitate responses during flood	Institutional arrangements for emergency management have been based on Disaster Management Law of 24/2007 by National Board for Disaster Management (BNPB). The flood management guideline of DKI Jakarta, which was prepared based on the Government Regulation 35/1991 and the Presidential Decree 3/2001, stipulates flood warning and flood fighting. Insufficient facilities and budget have been obstacles for application of the guideline.	The local disaster prevention plans include detailed plans for patrol, flood warning, evacuation, relief, and flood fighting along with job demarcation of relevant agencies. The Flood Fighting Law facilitates flood fighting activities for both preparedness and during flood. Following the modernization of life style, decreasing numbers and aging members, who participate in flood fighting corps, becomes an issue in Japan, although more incentives are provided by institutional reforms.
Institutions to facilitate recovery from flood damage	BNBP facilitates comprehensive recovery programs (Willitts-King, 2009), e.g. rescue and evacuation of victims, assets, delivery of basic needs, protection, recovery of facilities and infrastructure stipulated in the Disaster Management Law of 24/2007. Supports by bilateral or international donor agencies played larger roles for recovery activities in the past for large scale floods such as in 2002 and 2007.	The local disaster prevention plans include detailed procedures for recovery from flood damage including rehabilitation of infrastructure, recovery of economic activities, and mental care. There are institutional supports including special emergency projects for the control of severe river disaster based on the National Burden Sharing of Expenses for Rehabilitation of Damaged Public Works Facilities Law.

Table 2.10 Comparison of Effectiveness of Institutions in Jakarta and Tokai (2/2)

Performance Indicators	Results of Evaluation and Data Sources	
	Jakarta, Indonesia	**Tokai, Japan**
Organizations and inter-sectoral cooperation	BNPB was established in 2008 to replace the former ineffective performing government body responsible for disaster management. BNPB coordinates inter-sectoral ministerial meetings for flood management in Jakarta especially aiming at smooth emergency management. However, actual coordination throughout the flood management cycle is still limited due to lack of resources including budget, material, and practical guidelines.	Cabinet Office has the function of coordinating inter-sectoral agencies for disaster management including flood management. However, inter-sectoral cooperation is still limited because of the vertically segmented administrative system. Urban Rivers Flood Disaster Prevention Law, which was stipulated in 2003 to promote comprehensive flood management means by river basin unit in cooperation with all of relevant agencies, was applied to the severely affected areas by the 2000 Tokai storm.
Land use control	Uncontrolled development caused by inadequate land use control has been increasing the vulnerabilities to flood damage. Although the Minister of Public Works' Regulation 63/1993 stipulates the river and river conservation zones, the zones are often occupied by squatters or filled by solid waste. The Spatial Planning Law 24/1992 and the Government Regulation 69/1996 stipulate the land use controls for urban development. However, they have not been functioning well for flood management purposes. The replaced Spatial Planning Law of 26/2007 stipulates land use control for disaster mitigation purposes including flooding.	Various structural measures to reduce storm water run-off, e.g. utilization of underground spaces for temporary storm water storage, have been implemented because of the difficulty of land acquisition. Under the situation that about half of the population in Japan resides in the alluvial plain (Sato, 2005), there is no land use control applicable to the entire national land aiming at mitigation of flood damage although development in designated river and river conservation areas is restricted. Land use in flood plain is controlled indirectly by dissemination of flood hazard maps. The Urban Rivers Flood Disaster Prevention Law regulates land use in designated rivers.

Indonesia has more complex constraints to execute the laws in the literature than Japan, e.g. to securing lives of people below poverty line and conflicts against the vigorous actions by the government or police. Namely, the enforcement of laws in Indonesia is a difficult task without residents' understanding about the importance and essence of these laws related to flood management.

The on-going decentralization for flood management from the central to DKI Jakarta in Indonesia is still nothing more than transfer of authority from the central government to the local government. The government has a responsibility to demonstrate a better flood management by the decentralization, which enables decision-making to be made closer to the local community. However, the decentralization in Jakarta's case has been one of the reasons for delay of implementation of flood management projects. The decentralization has been also causing the inadequate flood management practices due to the unclear recognition of responsibilities for flood management and inadequacy of capacity to implement flood management means.

(2) Effectiveness of Flood Management Infrastructure

Table 2.11 shows comparison of effectiveness of flood management infrastructure between the case studies. Both cases need significant improvement of flood management infrastructure to cope with the design floods. The situation of the insufficient infrastructure is

common in the monsoon countries of Asia whether they are developed or developing. Even though the climatic and geographical similarity, the reliability of infrastructure in the Tokai region is higher than in Jakarta due to availability of infrastructure and to effectiveness of operation and maintenance of infrastructure.

However, the past reliability of infrastructure caused complacency prior to the 2000 Tokai floods and increased flood damage because of the insufficient awareness to flood threats and the inadequate flood warning and evacuation processes. The experience suggests that excessive reliance to flood management infrastructure may increase flood damage, and an appropriate combination of structural and non-structural measures is indispensable to prepare for flood threats and mitigate flood damage.

Table 2.11 Comparison of Effectiveness of Flood Management Infrastructure in Jakarta and Tokai (1/2)

Performance Indicators	Results of Evaluation and Data Sources	
	Jakarta, Indonesia	**Tokai, Japan**
Flood storage facilities	There is no large flood storage in the Jakarta urban area. A number of ponds existed in the Jakarta urban area have been disappearing due to residential and commercial development and losing their storage functions, although uncontrolled development is prohibited by laws.	Because of the limited land for flood storage reservoirs, alternative measures such as development of underground storage, storm water infiltration facilities, and multipurpose retarding basins have been promoted (e.g. Ichinomiya City, 2007).

Table 2.11 Comparison of Effectiveness of Flood Management Infrastructure in Jakarta and Tokai (2/2)

Performance Indicators	Results of Evaluation and Data Sources	
	Jakarta, Indonesia	**Tokai, Japan**
Levees	Jakarta is partially surrounded by circle levees, which protect the city area from flood water from upstream. The flood water was planned to be diverted by the west and east flood (*banjir*) canals, which are still under construction or improvement. Levee break and overtop occurred in most of major rivers during the 2002 and 2007 floods.	Inundation due to levee breaks was the largest cause of the flood damage. The levee break mechanism was analyzed after the Tokai storm, and levee strengthening measures have been implemented to make the levees persistent against floods over the design high water level (e.g.Aichi Prefecture, 2004).
Other structural measures	The central government and DKI Jakarta have drainage pumping facilities. However, the capacity is insufficient against the number of frequent flooding areas. Although main drainage canals have been developed, delay of development or inadequate maintenance of branch canals prevent from effective storm water drainage.	Comprehensive structural measures have been taken, which is facilitated by the Urban Rivers Flood Disaster Prevention Law. Those include dissemination of structures such as permeable pavement, infiltration pits, and subsidy by the government to facilitate the dissemination of the measures (e.g. Ichinomiya City, 2007).
Planning and design	There exist planning and designing standards, guidelines, and manuals for flood management infrastructure. However, they are not fully utilized because of the insufficient guidance and auditing by the government, user-unfriendly contents of the guidelines, and the difficulty in usage. It causes inconsistency of quality, low reliability of infrastructure, and difficulty in operation and maintenance of the facilities.	River facilities and drainage facilities are always required to be planned and designed by guidelines or manuals, which have been prepared under supervision of the government. Although the guidelines are effective to increase safety against flood disaster efficiently, negative effects of the guidelines have also been pointed out such as homogenization and humanization of the river environment.

(3) Degree of Awareness and Participation by the Local Community

Table 2.12 shows a comparison of the degrees of awareness and participation between the two case studies. There is no significant difference of degree of awareness by the local community between the two case studies. People in Jakarta have more interests in flooding events than in most areas in Japan including the Tokai region because of the frequent flooding events and the influence on their daily lives in Jakarta.

The relevant laws and regulations mandate broader community participation and information disclosure in Indonesia than in Japan throughout the entire flood management processes. However, public information is much more extensive and accurate in Japan compared to that in Indonesia. Moreover, accessing to the information is easier in Japan compared to in Indonesia. This is caused by various reasons including the difference of available information in terms of quality and quantity, channels for information disclosure including finance and technology, availability of means to access to the necessary information in the community side, and democratic background which determines the level of dependence on the government by the community.

In both of the two cases, raising awareness of flood threats, regardless of actual experience of flood damage or knowledge obtained from mass media or other information sources, inspires more community participation in flood management process. Moreover, the

community participation has been leading to pressure on government agencies to execute more comprehensive, effective, and efficient flood management means.

Table 2.12 Comparison of Degree of Awareness and Participation by the Local Community in Jakarta and Tokai (1/2)

Performance Indicators	Results of Evaluation and Data Sources	
	Jakarta, Indonesia	**Tokai, Japan**
Hazard map	DKI Jakarta has a hazard map, which shows frequent flooding areas. However, the actual inundation areas in the 2002 and 2007 floods were much larger than the areas shown in the hazard map. Hazard mapping technology is being transferred by international cooperation.	Hazard maps did not cover the entire inundation areas before the Tokai storm. Hazard maps have been drastically disseminated following the law amendment based on the experience of the Tokai storm. Hazard maps usually include expected inundation areas and depth and evacuation routes.
Joint planning	The Water Law of 7/2004 stipulates stakeholder participations in water resources planning. However, degree of joint planning differs case by case because of a lack of detailed guidelines. The Disaster Management Law of 24/2007 also encourages stakeholder participation throughout the disaster management process.	The 1997 River Law amendment stipulates a mechanism of participatory planning in water resources management. However, joint planning processes and methods differ by river basin and region. The Urban Rivers Flood Disaster Prevention Law stipulates joint planning for more effective flood management.
Information disclosure	Significant progress has been made for information disclosure following democratization and development of IT in Indonesia. However, information disclosure about flood management, which is open to the public, is still very limited.	Information disclosure regarding flood management has been drastically improved after the Tokai storm. The general public can easily access information, which includes hazard maps, hydrological and meteorological data, and relevant plans.

Table 2.12 Comparison of Degree of Awareness and Participation by the Local Community in Jakarta and Tokai (2/2)

Performance Indicators	Results of Evaluation and Data Sources	
	Jakarta, Indonesia	Tokai, Japan
Flood forecasting and warning systems (FFWS)	Early warning based on flood forecasting is encouraged in relevant law and regulations. However, the warning often does not reach especially for the poorest segment of the population, although the warning is supposed to be transmitted through flood operation community units (POKOMAS). Jakarta is developing the early warning systems for flood prone areas (Jakarta Post, 2009).	Flood forecasting and warning procedures have been improved based on lessons learned from the Tokai storm and other flood disasters. It includes improvement of water level monitoring systems, means to transmit the information, and clarity of warning to the general public. The local disaster prevention plans include procedures to transmit flood warnings to socially vulnerable groups.
Flood fighting practices	The Disaster Management Law of 24/2007 stipulates importance of flood fighting activities at the local level. Flood fighting activities during the 2002 and 2007 floods were not active because of insufficient resources including manpower and material against the extensive flooding area.	Flood fighting activities such as patrol and temporary levee reinforcement are well organized and executed based on the Flood Fighting Law. They supplemented insufficient physical capacity of flood control facilities during flood events of the 2000 Tokai storm (Kikuchi, 2003).
Insurance	Flood insurance is not common in Indonesia. Micro-insurance for flood damage has just launched in 2009 as a pilot project based on the feasibility study by GTZ in limited areas in DKI Jakarta (Kurniasari, 2009; Munich Re, 2009). The insurance costs IDR 50,000 / year and guarantees a one off payment of IDR 250,000 when the water level rises above 950cm at the Manggarai water gate in Jakarta.	Flood insurance is available only as supplementary contract of fire insurance. Flood insurance is operated by private insurers without governmental support. The enrollment rate of flood insurance in Japan is estimated as 46.2% (Yoshioka et al., 2002). JPY 100 billion was covered by the insurance (NLIRO, 2000) against the total direct loss of JPY 850 billion (Zhai et al., 2005).

(4) Data Availability

Table 2.13 shows comparison of data availability between the case studies categorized in hydrological and meteorological data, geographical data, guidelines for flood management, master plans, relevant literature, and registration of infrastructure.

Table 2.13 Comparison of Data Availability in Jakarta and Tokai (1/2)

Performance Indicators	Results of Evaluation and Data Sources	
	Jakarta, Indonesia	**Tokai, Japan**
Hydrological and meteorological data	Hydrological and meteorological observation is executed by various agencies. However, certain efforts in time, costs, and attention are required to collect data and check the quality.	A wide range of hydrological and meteorological data is available via the Internet. These data can be obtained from the portal sites even though the data belong to different agencies.
Geographical data	DKI Jakarta has made digital maps with a scale of 1/10,000 based on aero photos. Furthermore, digital maps on sub-district basis with a scale of 1/2,500, which separately indicate detailed locations of houses/buildings and the present land use are available (JICA, 2006b). However, complex processes are required to access to these geographical information.	A wide range of digital geographical information is disclosed to the public and available via various means including the Internet free of charge or at nominal costs. Digital elevation data of 5m mesh by aero laser scanner survey, which can be utilized for simulation of flood flows and flood inundation, is also available at nominal costs.
Social statistical data	Basic statistical data are available and disclosed through government websites or publications. However, the variety of data and update frequency is limited. Problems are often found in the data quality and it requires careful verification and modification.	Various statistical data are available and updated frequently. Many of data are accessible through government websites or other publications. Most of data are reliable and readily utilized or processed without rechecking and modification.

Table 2.13 Comparison of Data Availability in Jakarta and Tokai (2/2)

Performance Indicators	Results of Evaluation and Data Sources	
	Jakarta, Indonesia	**Tokai, Japan**
Guidelines for flood management	The Government Regulation 35/1991 obliges the government to establish guidelines for flood management. The flood disaster management guideline by BAKORNAS (BAKORNAS, 2007) focuses on emergency management.	Various manuals, guidelines and tools have been prepared under supervision by the government agencies. Utilization of these tools or guidelines is mandate for the entire cycle of flood management practices.
Master plans	The Water Law of 7/2004 stipulates water resources management plans including flood management to be established by the government (LEAD, 2006). Jakarta has flood management and drainage master plans established in 1973, 1991, and 1997 by international cooperation. However, complex issues have been delaying the implementation.	Local disaster prevention plans stipulate measures for flood management in detail. The contents have been improved to be more practical based on experience by the Tokai storm. The local disaster prevention plans of all municipalities in Japan can be viewed from the government portal site.
Relevant literatures	Public interest to flooding is high in Jakarta, and mass media frequently reports about flood related issues. However, systematic research is limited regardless of the frequent flood damage because of constraints of data availability and human resources. International cooperation projects often supplement the lack of information.	A number of research projects have been conducted after the Tokai storm from various points of view, e.g. engineering, sociology, institutions, and environment, etc. These research projects have been contributing to improve institutions for flood management and planning and implementation in practice.
Registration of infrastructure	Flood management facilities have not been fully registered and managed. Transfer of control from the central to local due to the on-going decentralization is also causing unclear locus of responsibility for infrastructure management.	Major flood management infrastructure is mostly registered and managed by authorities responsible for flood management. Moreover, local organizations and communities manage minor structures based on shared responsibility.

The basic information required for flood management is available in Jakarta, and the availability is better than those in other areas in Indonesia. However, the available data is not fully utilized due to constraints such as issues on capacity to utilize the data, accessibility to the data, and problems on data quality. Lower data accessibility prevents further progress in research, planning, and implementation of flood management. On the other hand, the access to data has been improved in Japan based on lessons learned from the Tokai storm and succeeding other flood disasters.

2.4.4 Factors Determining Effectiveness of Flood Management Systems

The comparison between the case studies in the Jakarta urban area, Indonesia and the Tokai region, Japan in **Section 2.4.3** leads to identification of the following factors determining effectiveness of flood management systems:

- Institutional support is essential for effective flood management. However, the effectiveness of flood management depends on capacity to implement the institutions, e.g. law enforcement, clear recognition of job demarcations, and resources to implement the institutions including organizations, human resources, and availability of detailed guidelines.
- Flood management infrastructure can mitigate flood damage if the infrastructure is

appropriately designed, operated, and maintained. However, over-reliance on the infrastructure or inappropriate operation of the infrastructure may increase flood damage. Therefore, adequate capacity is required for the entire project cycle of the flood management infrastructure.

- Awareness of flood threats and flood management by the local community is a key issue to mitigate flood damage. Appropriate information disclosure and participatory flood management approaches will raise the awareness.
- Data availability and data quality are fundamental to flood management processes. Accessibility to the available data and resources to utilize the data are also essential for effective flood management.

The level of these interdependent factors determines effectiveness of flood management. Given their interdependence, a comprehensive approach is required to improve effectiveness of flood management.

Clearly, as the case of Jakarta showed, developing countries face more complex constraints to improve effectiveness of flood management. The constraints include political and society volatility, financial difficulty, lack of social, physical, and human resources (Ref. **Section 2.3.2**), excessive disparity in wealth and other associated disparities such as education, accessibility to information, and a sense of values. It is essential to consider the constraints as

given conditions for improvement of effectiveness of flood management in developing countries. Therefore, measures that may work in developed countries might need to be modified for developing countries, namely, comprehensive capacity building methodologies, which are adaptable to developing countries under the various constraints, are required for effective flood management.

2.5 Establishment of Conceptual Model of Capacity Building for Flood Management

Based on the relationship among the elements of flood management systems (ref. **Section 2.2**), capacity building (ref. **Section 2.3**), and effectiveness of flood management (ref. **Section 2.4**), a conceptual model of capacity building for flood management shown in **Figure 2.15** is developed.

It begins with the risk triangle, which was described in **Section 1.2**, shows flood threats, vulnerabilities, and consequences. As described in **Section 1.7**, the threats and vulnerabilities are termed as flood severity X and the consequences of flooding Y become a function of X. Flood management system elements are termed as intervening variables Z, which can increase or decrease the threats and vulnerabilities and influence Y. Therefore, Y can be expressed as a function of both X and Z.

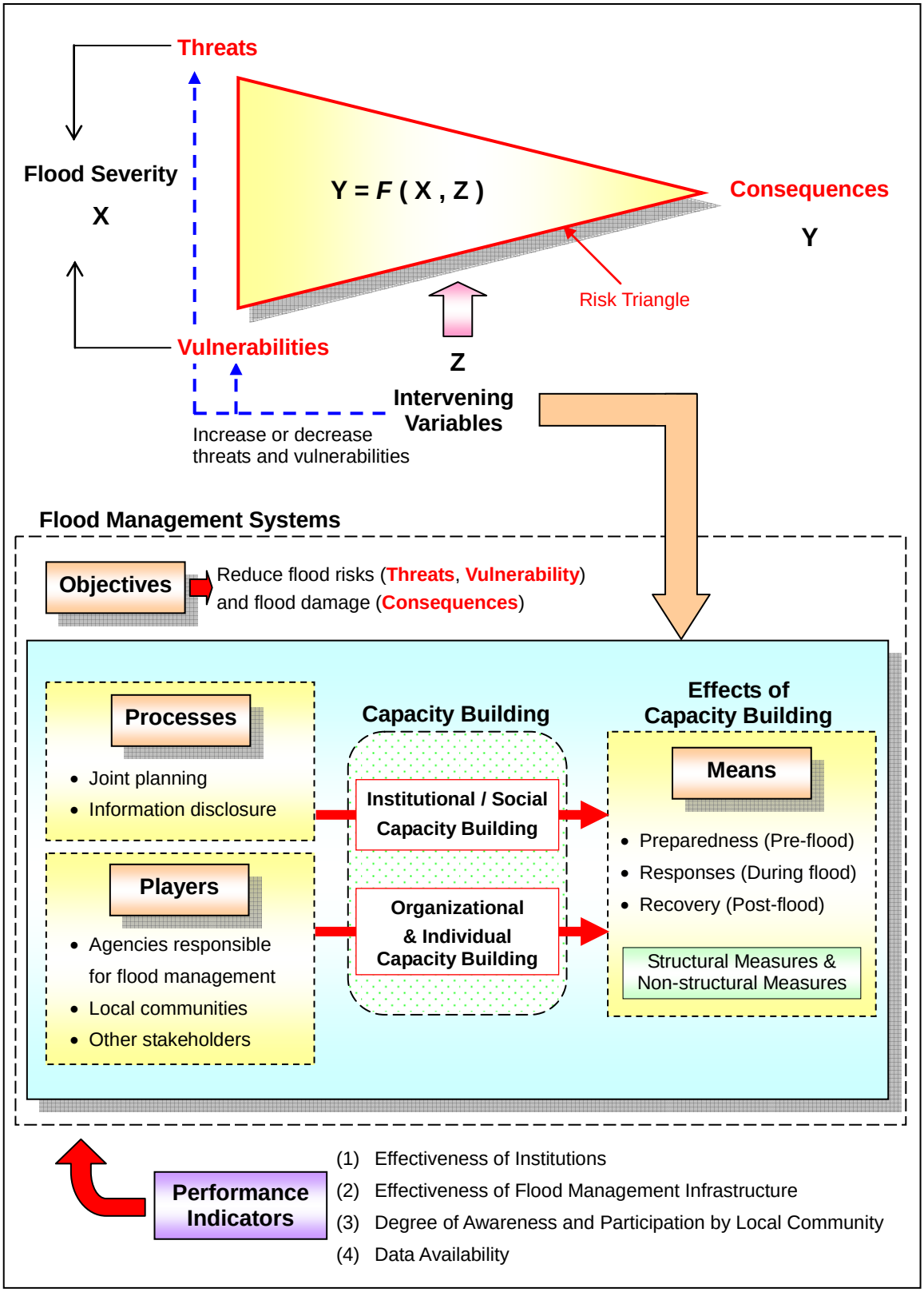


Figure 2.15 Conceptual Model of Capacity Building for Flood Management

The flood management systems consist of four elements, i.e. objectives, processes, players, and means as discussed in **Section 2.2**. The objectives are to reduce the flood risks, i.e. threats and vulnerabilities, and the flood damage, i.e. consequences of flooding. Out of the four elements, the remaining processes, players, and means work as the intervening variables Z. Capacity building will improve the processes and players and lead to improve the flood management means.

The processes include joint planning and information disclosure, which are improved by institutional or social capacity building. The players include agencies responsible for flood management, the local community, and other stakeholders. These are improved by organizational and individual capacity building. As an effect of the capacity building, the actual flood management means are improved. The means are categorized by preparedness (pre-flood), responses (during flood), and recovery (post-flood) as well as by structural and non-structural measures as described in **Section 2.2.3**.

Effectiveness of the flood management systems can be evaluated by the performance indicators, which were described in **Section 2.3.3** and applied to the case studies in **Section 2.4.3**. The performance indicators are categorized in (1) Effectiveness of institutions, (2) Effectiveness of flood management infrastructure, (3) Degree of awareness and participation by the local community, and (4) Data availability. Required capacity building for effective flood management

can be identified and measured by the performance indicators. **Figure 2.16** shows a conceptual diagram of the relationship between effectiveness of capacity building and negative consequences of flooding. Increasing effectiveness of capacity building improves effectiveness of flood management systems, and as a result, decreases negative consequences of flooding.

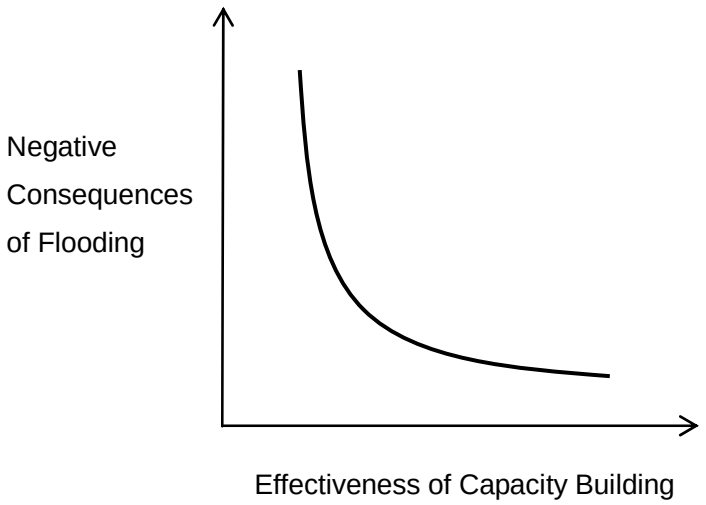


Figure 2.16 Relationship between Effectiveness of Capacity Building and Negative Consequences of Flooding

The conceptual model can be applied to flood management practices both in developed and developing countries. However, the model can be utilized to evaluate effectiveness of the flood management systems and identify capacity building needs especially in developing countries by the following reasons:

- Problems in developing countries are more complex and intertwined compared to those

in developed countries. Applying the conceptual model contributes to identify the problems and their interrelationship in a comprehensive manner.

- It is often observed in developing countries that superior infrastructure and human resources do not necessarily assure effective flood management because of the inadequate capacity as a whole system. Applying the conceptual model contributes to clarify required capacity building in the entire flood management system, namely not only in an individual level, but also in organizational, institutional, and social levels.

2.6 Evaluation of the Conceptual Model

This section aims to evaluate the acceptability and applicability of the conceptual model, which was established in **Section 2.5**. The conceptual model is compared to the Hyogo Declaration (United Nations, 2005) and the World Water Development Report 3 (WWDR3) (UNESCO, 2009b) since they reflect the latest development in disaster and water resources management complying with the paradigm shift described in **Section 1.3.2**, and therefore, are supported by extensive stakeholders. This section describes the conformity of the conceptual model to the relevant descriptions in the Hyogo Declaration and the WWDR3 to evaluate the stakeholders' acceptability and the applicability of the conceptual model to flood management practices.

Table 2.14 shows a comparison between the main subjects for disaster management in the Hyogo Declaration and how the conceptual model conforms to the subjects. The Hyogo Declaration was adopted in the World Conference on Disaster Reduction, which was held in Kobe, Hyogo Prefecture, Japan in 2005, based on discussions among extensive stakeholders including representatives from governments, international agencies, NGOs, and private parties. The Hyogo Declaration is the essence of the Hyogo Framework for Action (HFA), which is a guideline for disaster management from 2005 to 2015.

The World Water Development Reports (WWDR), which have been published every three years during the World Water Forum, include analysis and recommendations of comprehensive aspects in water resources management. The reports track progress of international development targets, particularly those of the MDGs, and introduce best practices as well as theoretical analyses to help develop ideas and stimulate actions for better water resources management. The reports have been cited and supported in various publications and websites by extensive stakeholders as guidelines in water resources management. **Table 2.15** compares the latest WWDR3 (UNESCO, 2009b), which was launched during the 5th World Water Forum in March 2009, and the conceptual model. Effective actions for capacity development mentioned in WWDR3 (p 254-257) are specifically abstracted to compare to the conceptual model.

Table 2.14 Comparison between the Hyogo Declaration and the Conceptual Model

	Abstract from the Hyogo Declaration	The Conceptual Model
1	We recognize the importance involving all stakeholders in disaster management, including governments, regional and international organizations and financial institutions, civil society, including non-governmental organizations and volunteers, the private sector and the scientific community.	The conceptual model describes processes and players as elements of flood management systems. The processes include joint planning, and the players include all stakeholders for flood management. Therefore, all aspects in the declaration in the left are incorporated in the conceptual model.
2	We recognize a culture of disaster prevention and resilience, and associated pre-disaster strategies, which are sound investments, must be fostered at all levels, ranging from the individual to the international levels. We must further build the resilience of nations and communities to disasters through activities in the context of the disaster reduction cycle, which consists of prevention, preparedness, and emergency response, as well as recovery and rehabilitation.	The conceptual model describes the means categorized in preparedness (pre-flood), responses (during flood), and recovery (post-flood), which conform to the context of the disaster reduction cycle mentioned in the declaration in the left. Moreover, institutional and social capacity building involved in the conceptual model conforms to the importance of the culture of disaster management mentioned in the declaration.
3	We concur that strengthening community level capacities to reduce disaster risk at the local level is especially needed, considering that appropriate disaster reduction measures at that level enable the communities and individuals to reduce significantly their vulnerabilities to hazards.	The contents of declaration in the left explain the importance of capacity building in the community level. The conceptual model exactly aims to clarify the capacity building. Moreover, a degree of awareness and participation by the local community is one of large categories of the performance indicators in the conceptual model.

Source: Abstract from the Hyogo Declaration is summarized from (United Nations, 2005).

Table 2.15 Comparison between the WWDR3 and the Conceptual Model

Effective Capacity Development Actions Mentioned in WWDR3		The Conceptual Model
1	Assessing institutional and human capacities	The conceptual model describes both institutional and individual capacity building. Capacity assessment is required as a first step of capacity building.
2	Strengthening institutional arrangements and capacity to support an agenda of change	The conceptual model describes all of the institutional, organizational, and individual capacity building that impacts on flood management programs and their implementation.
3	Engaging with civil society in developing its capacity	The conceptual model includes all stakeholders and capacity building for the civil society.
4	Stimulating professional knowledge	The conceptual model includes capacity building for professionals responsible for flood management.
5	Stimulating public awareness	The conceptual model describes public awareness through information disclosure and community participation.

Source: The effective actions are cited from (UNESCO, 2009b).

The comparison shows that the conceptual model conforms well to the aims and recommendations of both the Hyogo Declaration and the WWDR3. Therefore, the conceptual model can be accepted by extensive stakeholders, and as a result, can be applied to analyze and evaluate flood management practices in the context of paradigm shift.

CHAPTER 3

FORMULATION OF CAPACITY BUILDING METHODOLOGIES

3.1 Introduction

Following the procedures described in **Section 1.9.2**, this chapter formulates and tests capacity building methodologies for flood management in developing countries under climate change in the context of paradigm shift. **Section 3.2** analyzes two flood management planning case studies to identify the flood severity (X), consequences of flooding (Y), and intervening variables (Z), which were described in the conceptual model of capacity building for flood management established in **CHAPTER 2**. **Section 3.3** clarifies increased flood risks under climate change based on relevant literature review. Then, the increased flood risks under climate change specifically for the two case studies are speculated in **Section 3.4**. The section clarifies the required capacity building that mitigates the flood risks under climate change by analyzing how the intervening variables (Z) in the conceptual model are changed by capacity building. The clarified required capacity building under climate change is reorganized as capacity building methodologies in **Section 3.5**. The methodologies include principles of capacity building for flood management in developing countries under climate change and procedures to implement

the principles. **Section 3.5.3** evaluate the effectiveness of the capacity building methodologies by verifying how application of these methodologies decreases the uncertainty associated with flood management.

3.2 Analysis of Case Studies

This section analyzes two flood management planning case study reports to identify the flood severity (X), consequences of flooding (Y), and intervening variables (Z), which was described in the conceptual model of capacity building for flood management established in **CHAPTER 2**. The two case studies are selected to cover flood management both in urban and rural areas. The former is "The Study on Drainage Improvement in the Core Area of Metropolitan Manila" (JICA, 2005), which consists of a master plan for drainage improvement and a feasibility study for priority projects in the Manila metropolitan area, the Philippines. The latter is "The Study on Integrated Flood Management for Nyando River Basin in the Republic of Kenya" (JICA, 2009), which established a flood management master plan and implemented pilot projects. The research refers to other literature as well to support information in the case study reports and update the information.

Figure 3.1 shows the location of the Manila metropolitan area in the Philippines and the Nyando River Basin in Kenya.

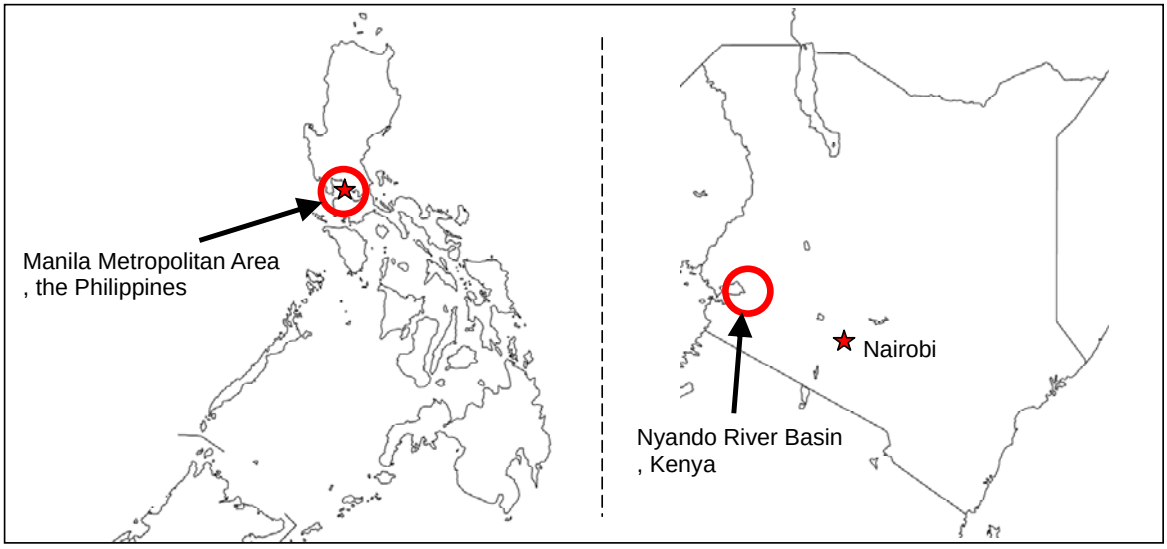


Figure 3.1 Location of the Manila Metropolitan Area, the Philippines and the Nyando River Basin, Kenya

3.2.1 Flood Management in the Manila Metropolitan Area, the Philippines

The city name of "Manila" originated from *may nilad* in Tagalog, which means the place where *nilad* grows. *Nilad* is a name of plants growing in marsh lands often seen in the downstream areas of the Pasig River, which bisects the city in the middle. The Manila metropolitan area has been suffering from frequent floods caused by insufficient drainage of storm water due to the low-lying geographical conditions as the city name implies regardless of continuous implementation of flood management means. Overflow from rivers including the Pasig River and high tide of Manila Bay often amplify the flood damage. **Figure 3.2** shows major rivers and waterways in the Manila metropolitan area.

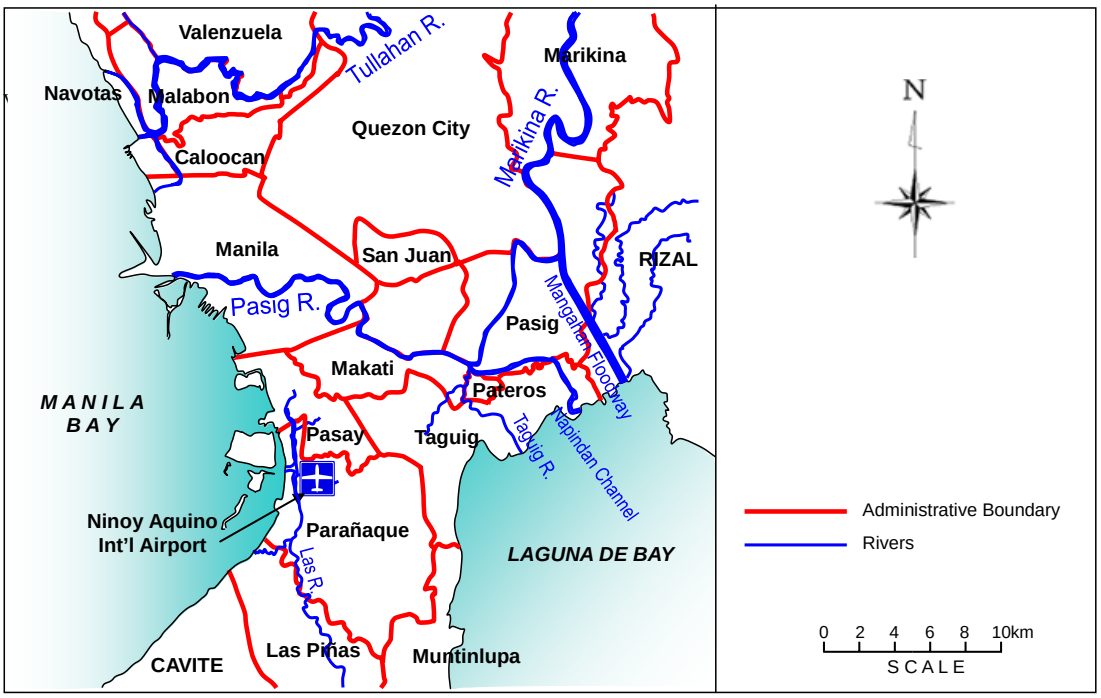


Figure 3.2 Major Rivers in the Manila Metropolitan Area

The recent severe flood caused by Typhoon Ketsana (It is called *Ondoy* in the Philippines), which was the largest flood damage on record, struck the Philippines including the Manila metropolitan area in September 2009. The flood inundated more than 80% of the land and caused 173 deaths in the Manila metropolitan area (NDCC, 2009), or officially called as the National Capital Region (NCR). An official of the Department of Public Works and Highways (DPWH), raised the following reasons for the flood damage in 2009 (Gatan, 2009):

1. Occurrence of extreme rainfall amount and intensity directly caused the flood damage. According to Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), the 24-hr rainfall of 455 mm recorded from 8 a.m., September

26 to 8 a.m., September 27 at the Science Garden in Quezon City is equivalent to a return period of more than 100 years.

2. Existing river channels do not have the capacity to flow the above extreme discharge, particularly Pasig with a present flow capacity of 500 m^3/s and Marikina with 900 m^3/s.
3. Existing internal drainage systems in Metro Manila cannot convey the unusual run-off. The old drainage systems constructed in 1975 are 70% silted and the design flood was based on 10-year return period. The design run-off coefficient of 0.4-0.5 was utilized taking care of percolation and infiltration. At present, due to the effect of urban development, which is being undertaken at an alarming rate, the runoff coefficient was significantly increased from 50% as originally designed to 95 %.
4. Many of existing internal drainage systems are clogged up due to indiscriminate throwing of garbage.
5. Some drainage inlets/manholes were purposely plugged by some residents to prevent proper drainage. It caused flooding from which they were able to earn money by providing services to people with stuck vehicles and also from elevated catwalks for pedestrians for a fee.
6. Illegal occupation of informal settlers along the waterways, which causes obstruction to the free flow of flood waters to the rivers.
7. Encroachment on waterways due to the uncontrolled rapid urban development.

Threats of flooding are expressed by the possibility of flood damage multiplied by the magnitude of flood damage as described in **Section 2.2.1**. The Manila metropolitan area is frequently attacked by tropical squalls with high rainfall intensity and typhoons generated in the Pacific Ocean. The Philippines Islands are hit by an average of six to seven typhoons per year (Shoemaker, 1991). Moreover, the uncontrolled development in the area has been amplifying the possibility of flood damage as emphasized as one of the reasons of the 2009 flood. The potential magnitude of flood damage also has been increasing following the urban growth with the continuous population inflow and the accumulation of investment in the area. That is to say, the threats of flooding in the Manila metropolitan area are increasing by the factors that amplify both the possibility and magnitude of flood damage.

Table 3.1 shows major vulnerabilities in the Manila metropolitan area, which can be derived from the case study report (JICA, 2005), the review of the 2009 flood, and other literature. Following the clarification in **Table 2.1**, the vulnerabilities are categorized into physical weaknesses and social weaknesses. **Table 3.1** shows that the Manila metropolitan area has compound vulnerabilities to flooding including lack of infrastructure, uncontrolled development, hazardous geographical conditions, less social cohesion, less resilience for recovery, lack of awareness, and security problems.

Table 3.1 Vulnerabilities in the Manila Metropolitan Area

	Subjects	Vulnerabilities
Physical Weaknesses	Lack of flood management infrastructure	• Existing drainage facilities are aged and require rehabilitation. • Solid waste, sediment, and illegal structures in the drainage canals reduce drainage capacity. • The capacity of the drainage facilities is insufficient to deal with increased flood run-off due to rapid urban development. • The flood warning system in the Manila metropolitan area called the Effective Flood Control Operation System (EFCOS) did not work properly during the 2009 flood because of budgetary constraints (Paglinawan, 2009).
	Hazard increase by excessive or uncontrolled development	• In 1986, developed land was 50.4 %, transformable land was 36.2 %, and unusable land was 13.2 %. After that, at least half of the transformable land was developed (JICA, 2005). • The population increased from 9.5 million in 1995 to 11.5 million in 2007 (NSO). The annual population growth rate during the period is 1.7%.
	Hazardous geographical conditions	• The Manila metropolitan area is located on the law alluvial plain of rivers including the Pasig River. • The area is facing the Manila bay and influenced by the tide level.
Social Weaknesses	Less social cohesion	• There exists decisive social disparity between the poor and the rich, and it causes segregation of the society. • The diversity in ethnic groups, language, and religion cause less social cohesion.
	Less resilience for recovery from disasters	• Most of the casualties by the 2009 flood were the poor residing along rivers and canals (*esteros*). • Insufficient cooperation between the government and community prevents recovery.
	Lack of KSAs	• The local community had insufficient information regarding flood threats and how to evacuate during the 2009 flood.
	Security problems	• Many lootings were observed during the 2009 flood.

The flood severity described by the threats and vulnerabilities mentioned above causes the devastative consequences of flooding such as a number of casualties and economic losses as observed in the 2009 flood. **Table 3.2** summarizes elements of flood management systems in the Manila metropolitan area. The elements are categorized in objectives, processes, players, and means as described in **Section 2.2**.

The Presidential Decree No.1566 promulgated in 1978 stipulates fundamental disaster management procedures and job requirements of agencies in national and local levels. The National Disaster Coordinating Council (NDCC) and the lower levels of disaster coordinating councils stipulated in the decree are responsible for coordination of all stages of flood management activities including preparedness, responses, and recovery. However, these councils have no functions to implement concrete flood management means. According to the Executive Order No.24 of 1987, DPWH is responsible for the construction, operation, and maintenance of flood control infrastructure. On the other hand, Metropolitan Manila Development Authority (MMDA) and Local Government Units (LGUs; 17 Cities and Municipalities comprising Metropolitan Manila) are responsible for drainage improvement and urban sanitation. PAGASA, towns, and *brangays* (the smallest administrative units) are responsible for flood warning.

Table 3.2 Objectives, Processes, Players, and Means of Flood Management in the Manila Metropolitan Area

Elements	Descriptions
Objectives	The national program on community disaster preparedness stipulated in the Presidential Decree No.1566 in 1978 states that the objectives of disaster management are **to save lives, prevent needless suffering, protect property, and minimize damages during disasters and calamities**.
Processes	NDCC issues the National Calamity and Disaster Preparedness Plan (NCDPP) which describes processes of disaster management. Under NDCC in the central government level, RDCC, MMDCC, PDCC, CDCC, MDCC, and BDCC are organized in the respective local government levels of region, Metro Manila, province, city, municipality, and *barangay*. These councils issue disaster management plans following the NCDPP. The processes of flood management can be stated as **implementation of civil protection programs through an integrated, multi-sectoral and community based approach and strategies for the protection and preservation of life, property and environment**. The primary objective of the NCDPP is to ensure effective and efficient implementation of the processes
Players	The players are **all stakeholders influencing decision-making for flood management** including communities, barangays, and the following members of MMDCC: - National Government Agencies (DPWH, MMDA, PAGASA, National Housing Authority (NHA), etc.) - LGUs, NGO's situated in the National Capital Region (NCR) - Office of Civil Defense
Means	**Structural measures**: Drainage canals and pumping stations managed by MMDA, floodways, levees, and flood control reservoirs managed by DPWH, dredging of sediment in the Pasig River is carried out by Pasig River Rehabilitation Commission (PRRC) **Non-structural measures**: Flood warning by PAGASA Activities of disaster operations centers in the national and local levels, which include awareness raising and flood fighting drills

Source: Derived and summarized from (Gatan, 2009; JICA, 2005; NDCC; PRRC, et al.)

Flood management activities in the Manila metropolitan area so far have been focusing on structural measures rather than non-structural measures. Not many local government offices possess appropriate technologies or institutions that would make possible immediate reactions designed to lessen the risks and impacts of flooding (Zoleta-Nantes, 2000), although fundamental flood warning systems are available. Moreover, lack of inter-sectoral coordination among governments and lack of coordination between government agencies and communities along with the limitation of the capacity of the disaster coordination councils are pointed out as one of reasons that increased the flood damage in 2009 (NNA, 2009; Paglinawan, 2009).

3.2.2 Flood Management in the Nyando River Basin, Kenya

The Nyando River is located on the western part of Kenya and one of rivers flowing into Lake Victoria. **Figure 3.3** shows the rivers and administrative boundaries of the river basin. The annual rainfall is about 1,300 mm ranging from more than 2,500 mm in the upper basin to 1,000 mm near the lakeshore (JICA, 2009). The primary industry in the river basin is agriculture, however, the low lying area called the Kano plain suffers from frequent floods.

The area of the river basin is 3,625 km^2 and the population is about 750,000 according to the 1999 census (JICA, 2009; Murase, 2009). Out of the population, about 250,000 people reside in the flood plain with the area of 567 km^2 (JICA, 2009).

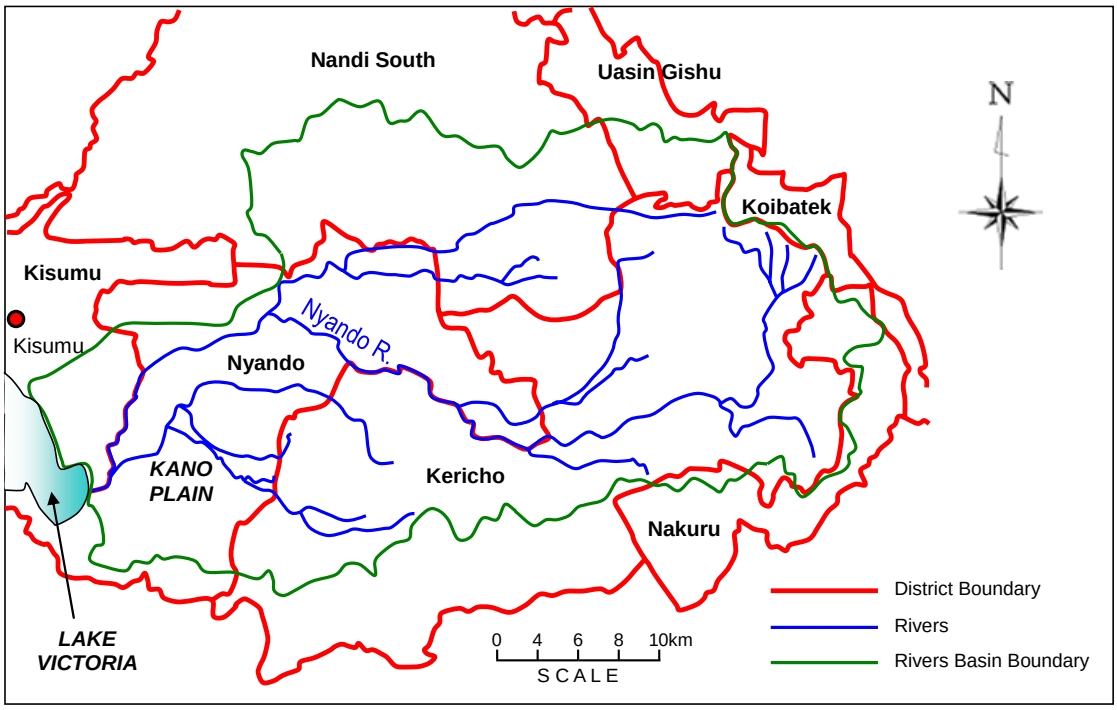


Figure 3.3 Rivers and Administrative Boundaries of the Nyando River Basin

The Kano plain is inundated almost every year, especially from April to June, when the southeast wind and south monsoon are dominant. The floods mainly affect agricultural crops of paddy, sugar cane, maze, and cotton and damage town and villages in the plain (APFM, 2004). The daily lives of the people in the area greatly affected by the flood every year although quantitative flood damage data is limited. The 1983 flood management master plan[8] proposed structural measures to mitigate flood damage in the river basin. However, most of the measures have not been implemented yet because of the financial constraints (JICA, 2009; Murase, 2009).

[8] Ministry of Water Development (MoWD), Pre-investment Study for Water Management and Development of the Nyando and Nzoia River Basins (ITALCONSULT), October 1983

The Kano plain and the Nyando river basin are listed as a priority area for flood management in the Ministerial Strategic Plan 2009-2012 (MOW, 2008) formulated by Ministry of Water and Irrigation (MOW).

The following are the features of the flood in the Nyando river basin clarified in the JICA study (JICA, 2009):

1. Flood flow arrives in a short period of time, around one to ten hours after rain starts, due to the short length of the rivers and the high velocity of flood flow caused by the geographical conditions.
2. Inundation is caused by overflow from river channels with insufficient capacity, flood water from adjacent river basins, and insufficient drainage of storm water. The inundation depth ranges from 0.1 to more than 3 m.
3. Inundation often remains more than one month because of the insufficient drainage facilities and the existing roads that prevent water flow. The inundation deteriorates irrigation facilities and agricultural production.
4. Information regarding flood warning and evacuation is limited. However, voluntary evacuation rates along the Nyando main stream are remarkably high at 80 to 100 % of the residents. According to a survey given to 350 communities in the flood plain regarding evacuation histories, 55 % of people claimed to have evacuated from flooding twice a year.

Threats of flooding in the Nyando river basin is the intense rainfall that increase river discharge. In addition, the relevant studies (APFM, 2004; JICA, 2009) point out the recent increasing rainfall intensity in the river basin, and the possibility of the relationship between the increasing threats of flooding and climate change.

Table 3.3 shows major vulnerabilities in the Nyando river basin, which can be derived from the study reports (APFM, 2004; JICA, 2009) and other literature (Ishikawa et al., 2010; Murase, 2009). The vulnerabilities are categorized into physical weakness and social weakness as in the case of the Manila metropolitan area.

The vulnerabilities in the area are mainly caused by the low income and insufficient infrastructure that is required for social services and physical distribution. Moreover, fragmented and limited governmental flood management activities amplify the vulnerabilities in the area. In addition, the population pressure also has been increasing the vulnerabilities as observed in the case studies in Jakarta and Manila.

The flood severity described by the threats and vulnerabilities mentioned above causes the continuous flood damage in the river basin.

Table 3.4 summarizes elements of flood management systems in the Nyando river basin. The elements are categorized in objectives, processes, players, and means as in the case of the Manila metropolitan area.

Table 3.3 Vulnerabilities in the Nyando River Basin

	Subjects	Vulnerabilities
Physical Weaknesses	Lack of flood management infrastructure	• Flood management infrastructure is insufficient and most of flood management infrastructure proposed in the 1983 master plan has not been implemented yet. • Exiting flood management structures are aged and require rehabilitation. • Sediment in the river beds decrease flow capacity of river channels. • There is no flood forecasting and warning system. • Safe evacuation routes during flooding are not secured.
	Hazard increase by uncontrolled or excessive development	• Increasing population accelerates development and deterioration of the river basin by agricultural and residential development, deforestation, and over-grazing. They have been causing soil erosion, sedimentation in the rivers, and sediment inflow to Lake Victoria.
	Lack of emergency flood fighting activities	• The government and community have insufficient flood fighting knowledge, skills, and material during floods.
	Hazardous geographical conditions	• The Kano plain is located in low lying downstream areas of the river basin. • The short length of the rivers and the steep slope in the upstream area cause the high velocity of flood flow and the short flood concentration time.
Social Weaknesses	Less resilience for recovery from disasters	• Financial difficulty of the government and the low income of the communities cause less resilience for recovery.
	Lack of knowledge, skills, and abilities	• Job responsibility of government agencies is unclear. • The local community has insufficient information regarding flooding mechanisms and how to cope with flooding.
	Security problems	• Thefts of household articles and livestock during floods are one of the largest concerns that make people to hesitate evacuation.

Source: Derived and summarized from (APFM, 2004; Ishikawa et al., 2010; JICA, 2009; Murase, 2009).

Table 3.4 Objectives, Processes, Players, and Means in the Nyando River Basin

Elements	Descriptions
Objectives	Draft National Policy of Disaster Risk Management (MSSP, 2009) states that the objective of disaster management is **to increase and sustain resilience of vulnerable communities to hazards through diversification of their livelihoods and coping mechanism**.
Processes	Draft National Policy of Disaster Risk Management (MSSP, 2009) states that disaster risk management encompasses **a full continuum from preparedness, relief and rehabilitation, mitigation and prevention**.
Players	The players are **all stakeholders influencing decision-making for flood management** including communities and the following national government agencies and the local members of the Disaster Management Committee (DMC): National level: - National government agencies (MSSP, MOW, etc.) - The other members of the national DMC District level (Members of the local DMC): - Local government agencies (Public Works Dept., Meteorological Dept., Police Dept., Water Services Board, Agriculture Dept., Health Dept., etc.) - Red Cross Society - NGO's (VIRED International, CARE Kenya, SANA International, ADRA, World Vision, etc.)
Means	**Structural measures**: Flood evacuation shelters (governmental offices, schools, churches, etc.) Improvement of roads, dredging of rivers and drainage canals, and construction of multipurpose ponds, which have been mainly conducted by NGOs with supports from donor agencies including USAID **Non-structural measures**: Flood warning by local government agencies Evacuation supports during flooding by the Red Cross Society Disaster management drills carried out by the Red Cross Society and NGOs

Source: Derived and summarized from (APFM, 2004; Ishikawa et al., 2010; JICA, 2009; Murase, 2009).

The Water Act of 2002 and the Presidential Circular No.1/2005 and No.1/2008 stipulate that the Ministry of Water and Irrigation (MOW) is responsible for flood control. On the other hand, the Ministry of State for Special Programmes (MSSP) under the Office of the President is responsible for coordination for disaster management including flood management. The Disaster Emergency and Response Coordination (DERC) in MSSP is in charge of the national Disaster Management Committee (DMC), which consists of agencies concerning disaster management. There are also DMCs in local levels along the administrative hierarchy.

However, flood management activities in the Nyando river basin have been mainly conducted by local communities supported by NGOs, but not by the governmental agencies. Especially, the "Food for Work" program, which construct flood management facilities such as levees, ponds, and shelters with labors from local communities by providing foods have been actively implemented in the areas, although the activities are still limited to cope with the frequent flood events (JICA, 2009). The aforementioned Ministerial Strategic Plan 2009-2012 (MOW, 2008) described an issue of the lack of inadequate policy and legal framework for flood control on the national level. The plan pointed out a need to provide direction and effective supervision for the water sector by putting in place mechanisms for continuous development and review of policies, laws, and regulations.

3.3 Flood Risks under Climate Change

Climate change will bring new flood threats by increasing volatility and vulnerability in flood management as explained in the problem statement in **Section 1.2**. This section describes how increased volatility and vulnerability influence flood management. Then, they will be utilized to speculate about increased flood risks in the case studies in the Philippines and Kenya under climate change.

3.3.1 Volatility in Flood Management under Climate Change

In this section, volatility in flood management under climate change is classified into natural volatility and social volatility as described in **Section 1.2**.

As to the natural volatility, IPCC's Climate Change and Water (Bates et al., 2008) categorized the observed and projected changes relating to water under climate change into precipitation and water vapor, snow and land ice, sea level, evapotranspiration, soil moisture, runoff and river discharge, and patterns of large scale variability. All of the categories influence patterns of flooding as summarized in **Table 3.5**. As much of literature shows, impacts of climate change vary by location and climate change will increase magnitude and frequency of flooding locally.

Table 3.5 Influence of Climate Change in Flooding

Subjects	Influence of Climate Change in Flooding
Precipitation and water vapor	• Increase in quantity and intensity of rainfall escalates flood run-off and flash floods. • Increase in water vapor amplifies generation and magnitude of tropical cyclones.
Snow and land ice	• Melting snow and land ice changes flood patterns and magnitude.
Sea level	• Sea level rise increases storm surges, accelerates coastal erosion, and deteriorates water drainage in the coastal areas.
Evapotranspiration	• Evapotranspiration may change rainfall pattern and soil moisture, although the direct impact on flood-runoff is still difficult to project.
Soil moisture	• Increase in soil moisture decreases water retention capacity.
Runoff and river discharge	• Climate change increases oscillation of flood run-off and river discharge.
Patterns of large-scale variability	• Global climate patterns are changed by climate change, and therefore, flooding patterns are also changed.

Source: The subjects are described in (Bates et al., 2008).

The change in the external forces under climate change including rainfall, water level, and discharge need to be appropriately estimated for effective flood management. However, rapidity of change, uncertainty, and complexity of the natural volatility under climate change causes difficulty in appropriate flood management planning and implementation.

The natural volatility may amplify the existing social volatility in developing countries. **Table 3.6** describes how the social volatility, which is categorized in society, institutions, and politics regarding flooding, is influenced by climate change.

Table 3.6 Social Volatility regarding Flooding under Climate Change

Subjects	Volatility regarding Flooding under Climate Change
Society	• Increasing flooding amplifies volatility in society caused by reasons including increasing poverty by flood damage, epidemics of waterborne diseases, and economic stagnation.
Institutions	• The existing institutions may not be able to cope with unexpected flood events under climate change. It causes inadequate emergency management and delay of recovery.
Politics	• Unexpected and extreme flood damage under climate change increases instability in politics along with the unstable society.

3.3.2 Vulnerability in Flood Management under Climate Change

The existing vulnerabilities to flooding are amplified by the increased volatility under climate change. **Table 3.7** shows how the vulnerabilities to flooding, which are categorized in physical and social weaknesses as described in **Table 2.1**, are influenced by climate change. The natural volatility represented by the escalating oscillation of climatic events and increasing uncertainties and complexity amplifies the physical weaknesses. Simultaneously, the social volatility escalated by climate change including unstable society, lack of institutions, and instability in politics amplifies the social weaknesses. That is to say, climate change increases both probability and magnitude of flood damage by amplifying and complicating the existing vulnerabilities.

Table 3.7 Amplified Vulnerabilities under Climate Change

	Subjects	Examples
Physical Weaknesses	Lack of flood management infrastructure	• The safety level of the existing infrastructure will be lowered by increased magnitude of flooding. • Reliability of the existing flood forecasting and warning systems will be lowered by the escalated meteorological and hydrological oscillation. • The existing infrastructure can be damaged by extreme flood events.
	Hazard increase by excessive or uncontrolled development	• Excessive or uncontrolled development may amplify the vulnerabilities more instantly, for example: - Extreme rainfall associated with excessive watershed development will increase flood run-off, flash floods, and debris flows instantly due to decreasing water retention capacity. - Sea level rise associated with uncontrolled coastal area development will increase flooding due to the deteriorated drainage conditions.
	Lack of emergency flood fighting	• Effects of flood fighting activities will be decreased if the magnitude of flooding is extreme.
	Hazardous geographical conditions	• Hazards in flood plains, coastal areas, and slide areas will be increased.
Social Weaknesses	Less social cohesion	• Extreme flood damage may weaken social cohesion, e.g. deteriorating mutual aid, adding to segregation, and alienation of socially disadvantaged groups.
	Less resilience for recovery from disasters	• Increased flood damage may delay recovery due to poverty and financial deficit of government agencies.
	Lack of knowledge, skills, and abilities	• Traditional and indigenous knowledge, skills, and abilities may not be able to cope with extreme flood events.
	Security problems	• Extreme flood damage may deteriorate security caused by the volatile society and politics.

3.4 Application of Increased Flood Risks under Climate Change to the Case Studies

The following describes how flood risks and consequences are influenced under climate change in the above mentioned case studies in the Philippines and Kenya. Then, the research clarifies required capacity building to mitigate the increased flood risks and the negative consequences of flooding.

3.4.1 Flood Risks and Consequences under Climate Change in the Manila Metropolitan Area, the Philippines

According to the report by WWF regarding a climate vulnerability ranking of major coastal cities in Asia (WWF, 2009), Manila is ranked first in its exposure to climate impacts among eleven cities (Calcutta, Dhaka, Bangkok, Phnom Penh, Ho Chi Minh, Kuala Lumpur, Singapore, Jakarta, Shanghai, Hong Kong, and Manila). The vulnerability was evaluated by the susceptibility of the city impacted by 1 m sea-level rise and 2 m storm surge, historical frequency of extreme weather events including flooding, and frequency of tropical storms and surges. Manila is highly exposed to all of the evaluation criteria that trigger flooding, and therefore, climate change may worsen the situation significantly.

In addition to these threats mentioned in the report, the escalating oscillation of the meteorological and hydrological events under climate change may make the flood forecasting

and warning and the operation of infrastructure difficult. These threats will amplify the existing vulnerabilities to flooding in the Manila metropolitan area. For example, the safety level of the existing aged and insufficient infrastructure will be lowered further by the increased external forces. The vulnerabilities caused by the excessive or uncontrolled development, the poor housing conditions, and the inadequate solid waste management associated with the population growth will be increasingly amplified along with the increased threats under climate change. Moreover, the social disparity and segregation can be amplified as the wealthy people are able to move to the safer places, while the poor people are allowed to live only in hazardous areas.

As a result of the increased flood severity under climate change, negative consequences of flooding will be escalated. These include more casualties caused by worsened flooding, more damage to assets and investment, more severe local and national economic stagnation, more deteriorating security, and more unstable situations in society and politics.

Figure 3.4 summarizes how climate change influences flood severity, which is categorized by threats and vulnerabilities, and consequences of flooding in the Manila metropolitan area.

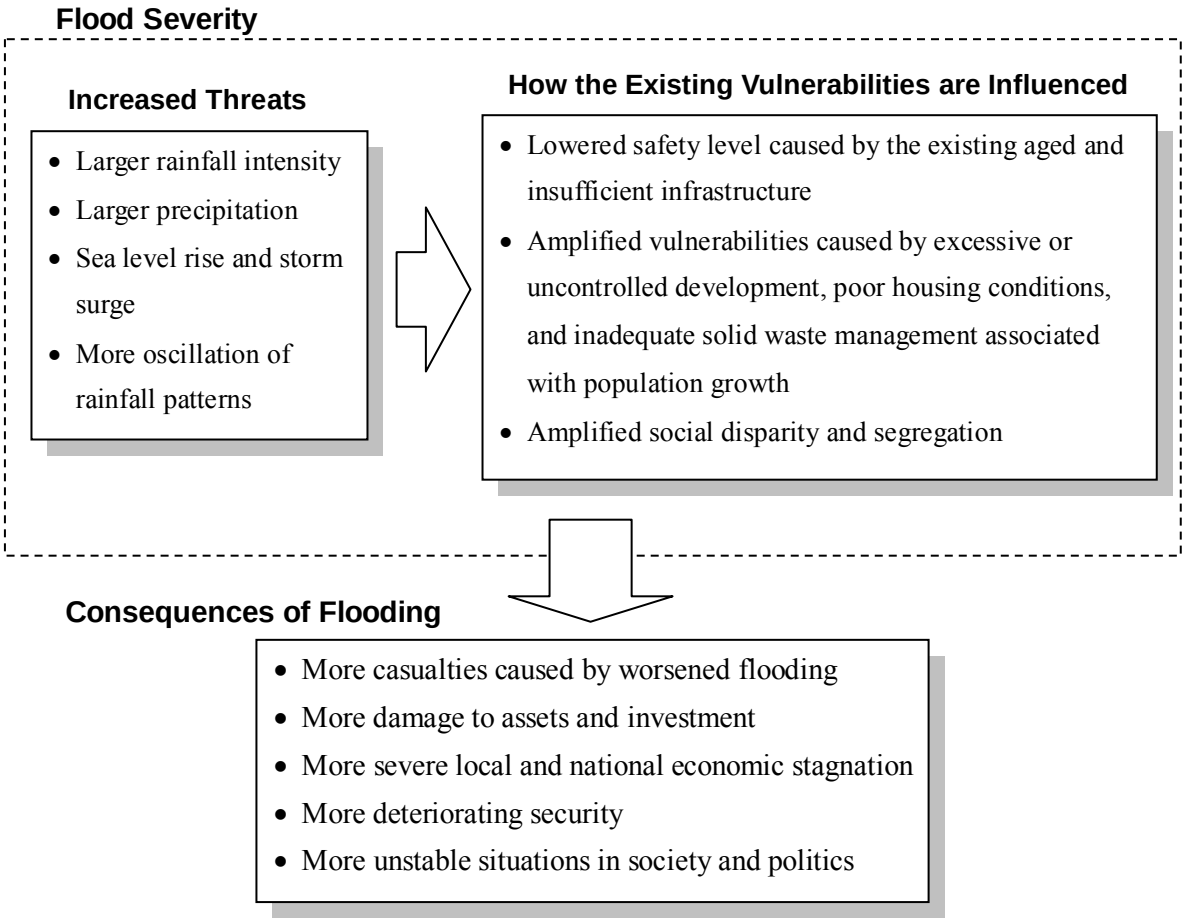


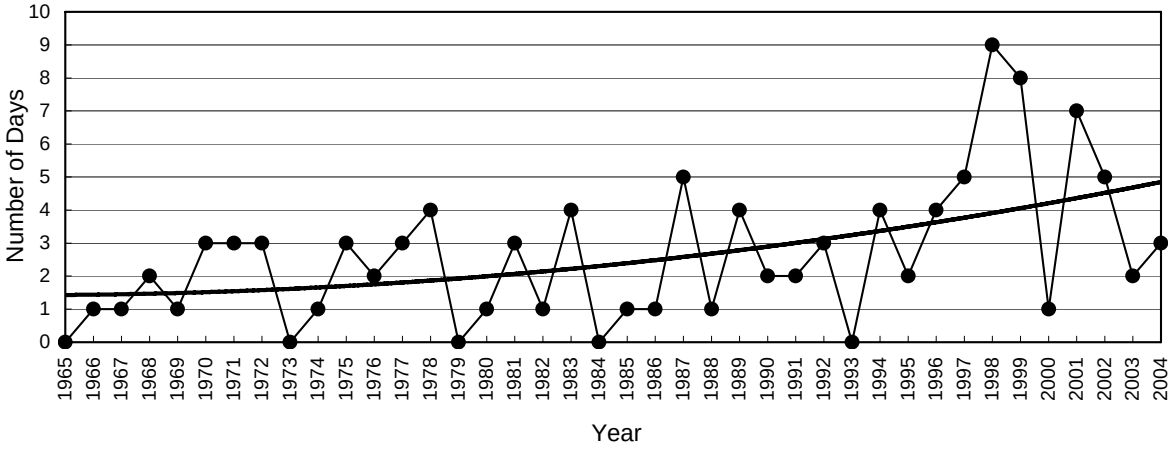
Figure 3.4 Flood Severity and Consequences under Climate Change in Manila

3.4.2 Flood Risks and Consequences under Climate Change in the Nyando River Basin, Kenya

The study report (APFM, 2004) pointed out the probability that climate change has been causing the recent increasing rainfall intensity in the Lake Victoria basin. In addition, more variable water levels of Lake Victoria and more extreme quantity and intensity of rainfall in the East Africa including the Lake Victoria basin are projected under climate change (WWF, 2006).

The area including the Nyando river basin is nominated as a hotspot for high mortality risk due to increasing frequency and magnitude of drought and flood under climate change (Arnold et al., 2006).

According to the JICA study report (JICA, 2009), average annual rainfall of Kisumu, Kericho, and Tinderet stations respectively representing downstream, middle reach, and upstream of the river basin shows no specific trend and was almost stable between 1965 and 2004. However, the number of days with more than 50 mm/day of rainfall shows the long-term increasing trend as described in the records of the Kericho station in **Figure 3.5**. The report showed that the trend accorded well with the long-term trend of temperature increase. Then, the report referred to the influence of climate change on flooding and proposed adaptation measures including both structural and non-structural measures to cope with the increased flood risks.



Source: The graph is shown in (JICA, 2009) based on the original data from Lake Victoria South Water Service Board (LVSWSB) database.

Figure 3.5 Number of Days with More than 50 mm/day Rainfall in Kericho

Increased threats in the Nyando river basin under climate change are larger rainfall intensity and precipitation as in the case in Manila. These threats will amplify the existing vulnerabilities to flooding. In the upstream area, more frequent flash flood and debris flow will be expected due to the larger rainfall intensity. The increased erosion will cause more sedimentation in the river channels and river mouth, and they will cause more severe flooding in the middle and lower reaches. Although the communities in the Nyando river basin are more self-sufficient, as the high voluntary evacuation rate implies, compared to the case in Manila, more frequent and more severe flooding will deteriorate their daily lives and socioeconomic situations. The prolonged inundation period causes economic stagnation and deteriorates sanitary conditions. The low resilience for recovery and accompanying economic anxiety causes security deterioration and eventually, permanent out migration.

3.4.3 Required Means and Capacity under Climate Change

The above mentioned increased flood risks and anticipated negative consequences of flooding require improvement of flood management means as well as capacity building to implement the improved means. **Table 3.8** summarizes how the flood management means need to be improved under climate change in the context of the paradigm shift and required capacity to implement the means.

Table 3.8 Flood Management Means under Climate Change and Required Capacity to Implement the Means

Stages	Structural Measures	Non-Structural Measures
Preparedness (Pre-flood)	• Infrastructure is an effective mean to reduce flood risks. However, it is required to recognize the limitation of the capacity of structural measures to avoid excessive reliance during extreme flood events anticipated. → The planning and designing capacity of adequate scale of infrastructure based on appropriate estimation of external forces is required.	• Mobilization of all feasible measures are required to prepare for the increased flood risks including awareness raising, land-use control, insurance, hydrological and meteorological monitoring, and institutional set-up. → All institutional, organizational, and individual capacities are required, which facilitate understandings and implementation of the measures.
Responses (During flood events)	• Making utmost use of existing resources is required to cope with increased external forces including improved operation of structures and flood fighting activities. → Capacity for accurate and timely implementation of the measures and proper decision-making under emergency situation is required.	• Minimization casualties have to be the first priority under increased threats by climate change, which include timely patrol, warning, evacuation, and relief. → Awareness-raising and drilling enable relevant agencies and communities to act properly under emergency situations.
Recovery from Flood Damage (Post-flood)	• Prompt rehabilitation of structures, which include infrastructure and housing, is required to cope with more frequent flood events under climate change. → Capacity for accurate and equitable evaluation of flood damage is required for succeeding rehabilitation and improvement of the future flood management.	• Prompt measures for resettlement of habitation are required to cope with more floods under climate change, e.g. insurance, mental care, and institutional supports. → All institutional, organizational, and individual capacities are required, which facilitate understandings and implementation of the measures.

Infrastructure is an effective and efficient means to reduce inundation areas even under increased flood threats by climate change. **Table 3.9** shows inundation area in the Pasig-Marikina Basin in the Manila metropolitan area simulated for 12 cases, i.e. three climate scenarios, two infrastructure scenarios, and two return periods by a joint study of ADB, JICA and the World Bank (Muto, 2009).

Table 3.9 Inundation Area in the Pasig-Marikina Basin

Simulation Case		30-year Flood		100-year Flood	
		Existing Structures	Implementing Current Master Plan	Existing Structures	Implementing Current Master Plan
1	Status quo climate	34.6 km^2	14.7 km^2	53.7 km^2	29.1 km^2
2	B1	42.5 km^2	20.8 km^2	63.2 km^2	40.1 km^2
3	A1FI	47.0 km^2	22.8 km^2	68.0 km^2	44.1 km^2

Source: ADB-JICA-WB Joint Study: Climate Change Impact and Adaptation in Asian Coastal Cities – Case of Metro Manila (Muto, 2009). The three climate scenarios[9] are based on the scenarios described in the IPCC Special Report on Emissions Scenarios (SRES) (IPCC, 2000).

The result of the simulation implies that infrastructure development steadily decreases flood damage regardless of under the status quo climate or the climate change scenarios. Simultaneously, considerable inundation areas will remain in all the cases even after

[9] B1 scenario describes a convergent world, with the same global population as A1 (a global population that peaks in mid-century), but with more rapid changes in economic structures toward a service and information economy. A1F1 is one of A1 scenarios (a world of very rapid economic growth, a global population that peaks in mid-century and rapid introduction of new and more efficient technologies), but the technological change is fossil intensive.

implementation of the current master plan. Therefore, non-structural measures to minimize flood damage are also required in parallel with structural measures. The situation is common in developing countries where implementation of infrastructure development with a high design flood level is realistically difficult due to financial and other technological constraints. Consequently, capacity for both structural and non-structural measures described in **Table 3.8** is essential and capacity building to achieve the goal is required.

3.5 Formulation of Capacity Building Methodologies

This section formulates capacity building methodologies for flood management in developing countries under climate change based on the required capacity clarified in **Section 3.4**. The methodology consists of principles and procedures to implement those principles. The principles are fundamentals of any decision-making when planning or implementing capacity building for flood management in developing countries in the context of the paradigm shift where the negative influence of climate change is anticipated. The procedures are guidelines to implement the simplified principles, which explain processes of capacity building consisting of how we identify resources and constraints for flood management, how we improve the quality of the resources, and how we make the most use of the resources.

3.5.1 Principles of Capacity Building for Flood Management in Developing Countries under Climate Change

The following four principles for capacity building can be derived from the required capacity to cope with the increased flood threats under climate change discussed in **Section 3.4**:

Principle 1: Structural Measures & Non-structural Measures

Capacity to implement both structural and non-structural measures needs to be developed.

Principle 2: Institutional, Organizational, and Individual Capacity

All institutional, organizational, and individual capacity is crucial.

Principle 3: Leadership & Decision-Making

Leadership and decision-making capacity are more necessary under increased flood risks.

Principle 4: Three Es (Effectiveness, Efficiency, and Equity)

Capacity to secure the three Es is the key to increasing feasibility of flood management means.

Principle 1 includes capacity building to assess appropriate types and scales of structural measures. Flood threats in many developing countries can be reduced significantly by structural measures with less investment compared to developed countries. Non-structural measures are also essential to reduce the flood threats and negative consequences of flooding under the present low level of infrastructure development. Moreover, the non-structural measures

are critical avoiding catastrophic damage when the magnitude of flooding exceeds the design flood levels. Therefore, capacity to implement both structural and non-structural measures needs to be developed in a balanced manner to cope with increasing flood threats under climate change.

Principle 2 shows that flood management systems do not necessarily function as intended when any institutional, organizational, or individual capacity is inadequate. Superior fundamental laws and human resources are becoming available in many developing countries. However, a number of factors harming the integrity of institutional, organizational, and individual capacities have contributed to inadequate flood management. For example, lack of detailed regulations cause malfunction of flood management systems. Inadequate organization causes lack of a chain of command for emergency management. Lack of understanding due to insufficient information or education causes unreliable actions during floods. Undermined morale of individuals due to few incentives or corruption causes irresponsible actions and more flood damage. In contrast, if all the institutional, organizational, and individual capacities are fairly developed and complements each other, flood management systems function in excess of a certain level or at least catastrophic damage can be avoided.

Principle 3 is paramount for proactive and timely flood management under the increasing complexity and uncertainty due to climate change and changing paradigm following the progress of democratization and diversification of values among stakeholders. Especially,

emergency management during flood events requires strong leadership and swift and adequate decision-making to avoid loss of life or significant economic loss. Usually, accurate and sufficient data, KSAs (knowledge, skill, and ability), and clear authority and responsibility are required to exercise leadership and expedite decision-making.

Principle 4 shows that feasibility of flood management means is dependent on levels of the 'three Es' (effectiveness, efficiency, and equity). Effectiveness and efficiency of flood management means can be measured traditionally by cost-benefit analysis where social assets are accumulated. Alternatively, effectiveness is measured by other social impacts, e.g. preventing loss of life, enhancing social stability, and other natural and social environmental concerns in areas where economic analysis is unsuitable for flood management purposes, such as in rural areas. Lack of equity has been causing disparity, segregation, distrust of authorities, and unstable societies especially in developing countries, and as a result, causing delays or malfunctions in flood management means. In contrast, equity enhances resilience of societies to flood damage by promoting mutual aid and smooth recovery from flood damage.

3.5.2 Procedures to Implement the Principles of Capacity Building

As described in **Section 2.3.2**, implementation of capacity building is framed by three questions: how do we mobilize resources; how do we bring the resources together; and how do

we educate people? In other words, answers to the three questions are the capacity building procedures. **Figure 3.6** summarizes the capacity building procedures. The capacities that need to be developed under climate change are framed by elements of the four principles of capacity building identified in **Section 3.5.1**, i.e. 1) Capacity to implement both structural and non-structural measures, 2) Institutional, organizational, and individual capacities, 3) Leadership and decision-making capacity, and 4) Capacity to secure the 'three Es'. All of these capacities need to be incorporated and pursued throughout the capacity building procedures, which answer to the three questions, to establish effective flood management systems under climate change.

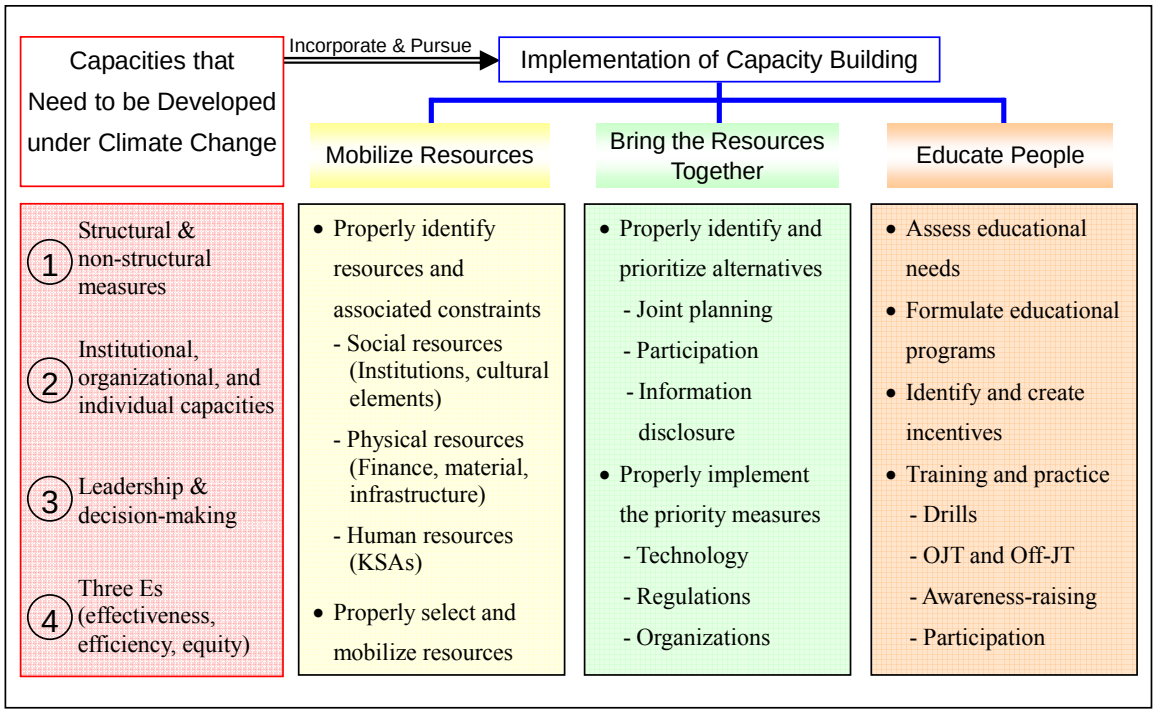


Figure 3.6 Capacity Building Procedures for Flood Management in Developing Countries under Climate Change

First, available resources, required resources, and associated constraints need to be identified properly to prepare for resources mobilization. These are processes of capacity assessment. Then, the appropriate resources for effective flood management need to be selected and mobilized. The resources are categorized by social, physical, and human resources as described in **Section 2.3.2**. Enhancing the processes of capacity assessment and selection and mobilization of resources improve effectiveness and efficiency of flood management.

Second, the resources need to be appropriately integrated as flood management means in practice. The flood management means are formulated by integrating a number of social, physical, and human resources. The formulation processes involve appropriate identification and prioritization of alternatives. Joint planning based on information disclosure and stakeholder participation, which brings human resources together, will improve the processes and the outcome. Then, the priority measures need to be implemented by adequate combination of resources, for example, management of flood control structures and flood warning systems by professional organizations applying suitable technology based on relevant laws and regulations.

Third, education of people is required to improve flood management practices. The people include officials of operational organizations responsible for flood management and citizens in local community. Educational needs are determined by assessing the gaps between the required capacity and the present capacity of human resources. The human resources meeting the

requirement can be fostered within the organization or hired from outside sources, if it is more effective and efficient. The processes of education include formulation of educational programs and identification and creation of incentives to enhance effectiveness of those programs. The educational programs are implemented through various means including flood fighting drills, on-the-job training (OJT), off-the-job trainings (Off-JT), and other participatory processes and awareness-raising activities throughout the flood management processes.

Table 3.10 shows a checklist to verify integrity of capacity building procedures for flood management in developing countries under climate change in the context of paradigm shift. The checklist consists of the three categories of capacity building procedures, i.e. mobilize resources, bring the resources together, and educate people. Each category consists of questions representing concrete elements of flood management systems, which influence outcome of capacity building. The questions were designed to verify that the capacity building procedures meet the four principles of capacity building. The checklist can be utilized not only to evaluate integrity of capacity building procedures, but also to find out subjects required to formulate or improve capacity building procedures to reduce flood risks and negative consequences of flooding.

Table 3.10 Checklist for Capacity Building Procedures (1/2)

Categories	Questions	Check
Mobilize Resources	Are available resources, required resources, and constraints for mobilization of resources identified?	□
	- Relevant laws and regulations (disaster and flood management)	□
	- Organizations responsible for flood management	□
	- Other stakeholders influencing decision-making	□
	- Tradition, customs, and culture concerning flood management	□
	- Flood control structures (levees, dams, detention basins, pumps, etc.)	□
	- Flood forecasting systems (monitoring, data analysis, etc.)	□
	- Flood warning systems (decision-making, communication, etc.)	□
	- Flood fighting systems (manpower, equipment, material, etc.)	□
	- Evacuation and relief systems (evacuation routes, shelters, etc.)	□
	- Hydrological data (water level, river discharge, tidal level, etc.)	□
	- Meteorological data (rainfall, etc.)	□
	- Other data required for flood management (social statistics data, etc.)	□
	- Financial arrangements for preparedness, responses, and recovery	□
	- Knowledge of human resources (technology, range of options, etc.)	□
	- Skills of human resources (experience, proficiency, etc.)	□
	- Ability of human resources (motivation, health, etc.)	□
	- Other resources required for flood management (guidelines, etc.)	□
Bring the resources together	Are flood management alternatives formulated and prioritized by integrating available resources appropriately?	□
	- Are available data properly interpreted?	□
	- Is application of technology appropriate?	□
	- Is application of guidelines appropriate?	□
	- Are appropriate stakeholders involved in the processes?	□
	- Is information disclosed properly?	□
	- Are decision-making processes appropriate?	□
	- Is leadership exercised throughout the processes properly?	□
	- Are prioritization criteria appropriate?	□
	- Is effectiveness pursued properly throughout the processes?	□
	- Is efficiency pursued properly throughout the processes?	□
	- Is equity pursued properly throughout the processes?	□

Table 3.10 Checklist for Capacity Building Procedures (2/2)

Categories	Questions	Check
Bring the resources together	Are priority flood management means implemented by integrating available resources appropriately?	□
	- Is application of technology appropriate?	□
	- Is application of manuals appropriate?	□
	- Are relevant laws and regulations established appropriately?	□
	- Are relevant laws and regulations properly enforced?	□
	- Do operational organizations responsible for flood management function properly including inter-sectoral cooperation?	□
	- Are appropriate stakeholders involved in the processes?	□
	- Is information disclosed properly?	
	- Are decision-making processes appropriate?	□
	- Is leadership exercised during the processes properly?	□
	- Is effectiveness pursued properly during the processes?	□
	- Is efficiency pursued properly during the processes?	□
	- Is equity pursued properly during the processes?	□
Educate people	Are required capacities of people assessed properly? (KSAs)	□
	Are the present capacities of people assessed properly? (KSAs)	□
	Are incentives for officials responsible for flood management identified and created properly?	□
	- Labor conditions (payment, hours of duty, welfare, etc.)	□
	- Significance (self-realization, satisfaction, ethics, etc.)	□
	Are motivations for community people for flood management identified and created properly? (hazard, nature of flooding, evacuation needs, etc.)	□
	Are educational programs formulated properly?	□
	- OJT and Off-JT (On purpose? Well planned? Continuous?) (expertise, comprehensiveness, ethics, etc.)	□
	- Drills (flood fighting, evacuation, relief, etc.)	□
	- Awareness-raising (quality and quantity of information, accessibility)	□
	- Are leadership and decision-making capacity fostered?	□
	- Is effectiveness pursued properly during the processes?	□
	- Is efficiency pursued properly during the processes?	□
	- Is equity pursued properly during the processes?	□

3.5.3 Capacity Building for Drainage Improvement in the Manila Metropolitan Area

The following focuses on the problem of the insufficient drainage capacity in the core area of the Manila metropolitan area to show an example of application of the capacity building methodologies. The background information is derived from the JICA study report (JICA, 2005). About 70% (52 km^2) of the core area relies on pumping for storm water drainage. The drainage facilities consist of 15 major drainage pumping stations, 74 km of open channels (*esteros*), 35 km of underground drains, and 400 km of conduits. However, the drainage capacity was decreased to a level of two-year protection from the original design level of 10-year protection. As also summarized in **Section 3.2.1**, the drainage capacity of the area has been deteriorated by the following reasons:

- Ten drainage pumping stations of the 15 stations have been working for more than 20 to 30 years since their constriction in the 1970s and 1980s, and some pumping stations are exceeding their service life of pumping equipment and appurtenant facilities.
- Lack of spare parts is reported at many of the pumping stations due to lack of proper O&M budget.
- Original functions of the drainage channels are missing due to huge deposition in the channels (920,000 m^3) and informal house building encroaching drainage channels (2,100 housings, 6,000 households).

Table 3.11 shows specific examples of how to address the questions in the checklist shown in **Table 3.10** for capacity building to cope with the problem of the insufficient drainage capacity in Manila. The capacity building procedures include identification of resources and constraints (mobilize resources), formulation and prioritization of alternatives by integration of the resources and implementation of the priority measures (bring the resources together), and human resources development to make the most use of the resources (educate people).

Table 3.11 shows that the causes of the insufficient drainage capacity are the inadequate O&M of drainage facilities, lack of inter-sectoral coordination, and activities of the local communities, which deteriorate the drainage capacity by illegal dumping and encroachment. Examples of the resources to be mobilized are the existing drainage facilities, relevant organizations, and local communities. Alternatives formulated by integrating the resources include rehabilitation of the existing facilities and construction of new floodways, which should be planned and designed based on reliable data and appropriate analytical methods. Required education for government officials includes enhancing knowledge and skills in hydraulic, economic, and financial analysis. Awareness-raising of communities about flood control facilities and flood hazards is also required for effective flood management. The evaluation criteria of the checklist may vary depending on background conditions of each case. The criteria often need to be determined through the participation in flood management practices.

Table 3.11 Capacity Building Procedures for Drainage Improvement in Manila

Categories	Questions in the Checklist	Capacity Building Procedures to Address the Questions
Mobilize Resources (Identify resources and constraints)	Are available resources, required resources, and constraints for mobilization of resources identified? - Flood control structures (levees, dams, detention basins, pumps, etc.) - Organizations responsible for flood management	The area has the existing well-developed drainage structures, but they are not functioning as designed because of the constraints including lack of O&M and the low awareness of the local communities. Activities of the relevant agencies including DPWH, MMDA, and NHA are limited by the constraints including lack of budget, lack of inter-sectoral cooperation, and distrust of the government by the local communities.
Bring the resources together (Formulate and prioritize alternatives & implement the priority measures)	Are flood management alternatives formulated and prioritized by integrating available resources appropriately? - Are available data properly interpreted? - Is application of technology appropriate?	The existing drainage facilities need to be utilized effectively, e.g. rehabilitation of pumping stations and dredging of canals. Then, combined effects with other alternatives such as construction of new floodways, strengthening of land use control, and flood warning need to be evaluated. To achieve the goal, accurate flood flow analysis are required, e.g. utilizing appropriate boundary conditions and analytical methods such as appropriate high tide level, boundary water levels, roughness coefficient, runoff rate, and ground levels for horizontal two dimensional analyses.
Educate people (HRD to mobilize resources and bring the resources together)	Are required capacities of people assessed properly? (KSAs)	Skilled officials and consultants with adequate educational background, e.g. in hydraulic engineering and economic and financial analysis, are required for the planning of the alternatives and implementation of priority measures.
	Are motivations for community people for flood management identified and created properly? (hazard, nature of flooding, evacuation needs, etc.)	Understandings of the function of flood control facilities, mechanism of inundation, timing and methods of evacuation can be the motivation of appropriate flood management practices in the local communities. Educational programs to enhance the understandings are required.

3.6 Evaluation of the Capacity Building Methodologies

Uncertainties which prevent smooth implementation of flood management means include technical, environmental, financial, organizational, political, and social aspects. Climate change amplifies these uncertainties, and therefore, makes decision-making for implementation of flood management means more difficult.

This section evaluates how the application of the capacity building methodologies formulated in **Section 3.5** decreases uncertainty toward flood management under climate change. **Section 3.6.1** proposes indicators to measure the level of uncertainty. The indicators are utilized in **Section 3.6.2** to show that the application of the capacity building methodologies decreases uncertainty to implement flood management means under climate change.

3.6.1 Indicators to Measure a Level of Uncertainty

There exist a number of uncertainties, which prevent or delay implementation of flood management means. **Table 3.12** shows major uncertainties that are often recognized as obstacles for project implementation, especially in developing countries. The table shows how the uncertainties prevent project implementation or required decision-making. Climate change has direct impacts on the technical and environmental uncertainties and also influences the other uncertainties indirectly.

Table 3.12 Indicators of Major Uncertainties for Flood Management

Category	Indicators of Uncertainties	Descriptions
Technical	Data availability	• Lack of data, such as insufficient projection of volume and intensity of rainfall, makes decision-making difficult.
	Data analytical skills	• Unreliable data analysis, such as usage of inadequate or technically not justified data and analytical methods, prevents appropriate decision-making.
Environmental	Environmental changes	• Uncertainties in environmental changes, such as climate change impacts on the ecosystem and the relationship with rainfall patterns, make decision-making difficult.
Financial	Project cost	• Lack of finance prevents project implementation. • Inappropriate financial analysis, such as usage of inadequate cost-benefit analysis methods and unrealistic interest rates, influences project feasibility.
	Economic situation	• Uncertainties in future economic situations, such as global and domestic economic status and exchange rate fluctuations, makes decision-making difficult.
Organizational	Leadership	• Lack of leadership, such as insufficient qualifications, techniques, and intelligence of decision-makers, prevents timely decision-making.
	Decision-making	• Lack of decision-making mechanisms, such as complex decision-making processes and insufficient information for decision-making, prevents smooth implementation of flood management means.
Political	Political situation	• Unstable political situations, such as frequent changes of regimes, delays necessary legislation.
Social	Awareness	• Lack of understandings about project effectiveness prevents project formulation and implementation.
	Social stability	• Unstable society causes unstable political situations and security problems.
	Security	• Security problems prevent smooth project implementation.

These uncertainties deteriorate project feasibility and priority regardless of the anticipated large negative impacts under climate change. Moreover, lack of institutional, organizational, and individual capacities along with the uncertainties often makes government or donor agencies to hesitate to invest in flood management projects.

3.6.2 Effectiveness of the Capacity Building Methodologies

Application of the capacity building methodologies formulated in **Section 3.5** will decrease the above mentioned uncertainties, make decision-making easier, and improve feasibility and effectiveness of flood management means. **Table 3.13** describes how application of the capacity building methodologies decreases the uncertainties toward project implementation.

Technical, financial, and environmental feasibilities are always emphasized during screening of candidate projects by the executing and donor agencies. These feasibilities are determined by secured budget, quantity and quality of human resources, data availability, impacts on natural and social environment, and security, etc. The feasibilities are decreased by a series of uncertainties. In contrast, capacity building decreases the uncertainties and increases clarity and sustainability of project effectiveness, and as a result, facilitates implementation of the projects.

Table 3.13 Decreased Uncertainties by Application of Capacity Building Methodologies

Uncertainties	Impacts of Application of Capacity Building Methodologies
Technical	• Enhancing capacity in data management and analysis, such as adequate meteorological and hydrological observations, adequate data storage, and technically justified data analysis, improves quality of planning and designing. It will make decision-making easier. • Appropriate combination of structural and non-structural measures, such as combination of construction of infrastructure and dissemination of information regarding flood hazard and evacuation, improves clarity of effectiveness of flood management means.
Environmental	• Enhancing capacity in projecting environmental changes, such as impacts of climate change on the eco-system, makes planning and designing more accurate and reliable.
Financial	• Institutional set-up to facilitate financial arrangement, such as prioritizing financial allocation to proactive measures, increases project feasibility. • Enhancing capacity in financial and economic analysis, such as theoretically justified and realistic cost-benefit analysis, contributes to set up more accurate financial arrangements.
Organizational	• Institutional set-up, such as establishing regulations regarding job demarcation of authorities and their inter-sectoral cooperation, clarifies authority and responsibility of organizations and improves flood management practices. • Enhancing leadership and clear decision-making mechanisms accelerates and improves implementation of flood management means.
Political	• Enhancing the 'three Es' (effectiveness, efficiency, and equity), such as providing public services and disclosing information to socially vulnerable groups, contributes more stable political situations and improves environment for flood management.
Social	• Enhancing community awareness about flood hazards and effectiveness of flood management means contribute to accelerate project implementation. • Enhancing the 'three Es' contributes to a more stable society by eliminating disparity and improves security problems.

CHAPTER 4

PROJECT OUTCOMES BY APPLYING

THE CAPACITY BUILDING METHODOLOGIES

4.1 Introduction

This chapter verifies the effectiveness of project outcomes by applying the capacity building methodologies formulated in **CHAPTER 3**. The same case studies in the previous chapters are utilized in **Section 4.2** to speculate the project outcomes. Then, **Section 4.3** evaluates how the application of the capacity building methodologies mitigates the flood risks under climate change and contributes to economic development in developing countries. **Section 4.4** interprets flood management case studies in the U.S. from a view point of capacity building. **Section 4.5** shows sample terms of reference (TOR) of a flood management study, which incorporates the capacity building methodologies.

4.2 Application of the Capacity Building Methodologies to the Case Studies

This section describes how application of the capacity building methodologies influences flood management practices under climate change. **Section 4.2.1** analyzes the case

study in the Manila metropolitan area and **Section 4.2.2** analyzes the case study in the Nyando river basin. Each case represents flood management in urban and rural areas respectively.

4.2.1 Application of the Capacity Building Methodologies to the Case Study in the Manila Metropolitan Area, the Philippines

The Manila metropolitan area is susceptible to increased flood threats under climate change due to the geographical conditions and the other vulnerabilities as described in **Section 3.4.1**. Application of the capacity building methodologies mitigates the vulnerabilities categorized by physical and social weaknesses as shown in **Table 4.1** and **Table 4.2**.

The tables show that application of the capacity building methodologies will reduce vulnerabilities to flooding, and as a result, mitigate the negative consequences of flooding anticipated under climate change. Simultaneously, the tables imply that capacity building of the whole society based on inter-sectoral cooperation is crucially important to respond to the complex urban problems. That is to say, inter-sectoral cooperation becomes increasingly required under escalated flood threats induced by climate change.

Although the Philippines have disaster coordinating councils in each level of the administrative hierarchy, which aim to facilitate coordination of relevant authorities, the weak authority of the councils has been preventing effective coordination under extreme disasters.

Table 4.1 Changes in Physical Weaknesses by Capacity Building in Manila

Subjects	Changes in Vulnerabilities
Lack of flood management infrastructure	• Enhancing assessment of the existing drainage facilities and institutional arrangement to facilitate rehabilitation of aged structures and promoting new drainage facilities will improve drainage capacity. • Institutional arrangement and law enforcement to restrict solid waste disposal and illegal structure in the drainage canals along with strengthening of the housing policy will improve drainage capacity. • Capacity building to determine appropriate and realistic combinations of structural and non-structural measures, such as more emphasis on warning and evacuation, will help to prevent catastrophic damage. • Institutional arrangements allocating necessary budgets to operate flood warning systems will facilitate timely evacuation during extreme flood events.
Hazard increase by excessive or uncontrolled development	• Institutional arrangement and technically equitable review to approve urban development plans will prevent uncontrolled development and further flood run-off increase. • Enhancing capacity to review and improve land use patterns, such as increasing green spaces and dissemination of permeable pavements, will mitigate flood-runoff. • Enhancing inter-sectoral cooperation to prevent excessive concentration of the population, such as creation of job opportunities outside the metropolitan area and further progress of agrarian land reforms, will prevent further excessive or uncontrolled development.
Hazardous geographical conditions	• Enhancing capacity to clarify water cycle mechanisms in the alluvial plain, such as interrelationship among the river flow, water level of the Lagna de Bay, and the sea water level of the Manila Bay, will contribute effective flood management planning and implementation. • Enhancing monitoring of the tidal level and implementing appropriate structural and non-structural measures, such as development of tide-gates, sea-walls, and high tide warning systems, will mitigate flood damage induced by the high tidal level.

Table 4.2 Changes in Social Weaknesses by Capacity Building in Manila

Subjects	Changes in Vulnerabilities
Less social cohesion	• Enhancing equity in public services, such as communications about flood hazards, accessibility to disclosed information, and participation opportunities in flood management activities, will improve social cohesion and resilience to flood damage. • Strengthening involvement of minority groups (e.g. ethnic groups, language, and religion), such as participation to flood management planning and practices, will improve social cohesion.
Less resilience for recovery from disasters	• Implementing a broad range of flood management means including flood insurance for the poor, institutional arrangement for resettlement of habitation, inter-sectoral cooperation for income generation of the poor, will improve resilience for recovery from disasters. • Enhancing relationship of trust between government and community, such as equitable treatment by government and awareness-raising of community, will facilitate recovery measures.
Lack of knowledge, skills, and abilities	• Enhancing information disclosure regarding flood hazards including improvement of accessibility to the information and education to the local community will help to prevent casualties due to delay or inadequate evacuation.
Security problems	• Inter-sectoral cooperation to improve the security situation will facilitate smooth evacuation during extreme flood events.

The administrative hierarchy has been developed based on the Local Government Code of 1991, which promotes decentralization in the Philippines. The decentralization has been contributing to enhancing capacity for project implementation at the local level. That is to say,

decentralization following the principle of subsidiarity[10] can be an element of capacity building. However, it is also a fact that lack of financial capability and inadequate capacity of the local government have been obstacles for effective flood management by a number of LGUs, which are responsible for drainage and flood warning. Although decentralization is one of means to improve public administration, obliged decentralization with inappropriate procedures and hasty reforms often causes problems in flood management.

Comprehensive capacity building covering institutional, organizational, and individual levels will help to realize the principle of subsidiarity. Moreover, capacity building is necessary to enhance the inter-sectoral cooperation and enable the authorities and communities to cope with increased flood risks under climate change.

4.2.2 Application of the Capacity Building Methodologies to the Case Study in the Nyando River Basin, Kenya

As in the case of the Manila metropolitan area, application of the capacity building methodologies reduces flood risks and negative consequences of flooding in the Nyando river basin. **Table 4.3** and **Table 4.4** show changes in the vulnerabilities categorized into physical

[10] The principle of subsidiarity is best known as a fundamental principle of European Union law. Subsidiarity is the idea that a central authority should have a subsidiary function, performing only those tasks which cannot be performed effectively at a local level.

weaknesses and social weaknesses by application of the capacity building methodologies.

As mentioned in **Section 3.4.2**, the local communities in the Nyando river basin are self-sufficient as often observed in rural areas in developing countries. People in the communities have been constructing and maintaining structures such as levees and drainage canals without significant supports from the government. However, lack of knowledge has been preventing effective and efficient implementation of flood management means.

Under the circumstances, **Table 4.3** and **Table 4.4** imply the possibility that awareness-raising of the communities and more involvement of government agencies will improve the quality of flood management practices significantly. Pilot projects during the JICA study (JICA, 2009) show the different levels of project outcomes depending on capacity of communities and other stakeholders including level of awareness of local communities, level of collaboration among stakeholders, level of supports from the government, and existence or nonexistence of leadership.

The case in the Nyando river basin shows that capacity building of all institutional, organizational, and individual levels is increasingly crucial for effective flood management also in rural areas under anticipated increasing flood threats induced by climate change, while outcomes of capacity building will appear more apparently and directly compared to urban areas.

Table 4.3 Changes in Physical Weaknesses by Capacity Building in the Nyando River Basin

Subjects	Changes in Vulnerabilities
Lack of flood management infrastructure	• Enhancing planning capacity will facilitate to formulate practical and effective flood management means consisting of both structural and non-structural measures. • Enhancing assessment of the existing structures and collaboration among local communities, NGOs, and government agencies will facilitate rehabilitation of the aged structures. • Enhancing assessment of river bed conditions will facilitate dredging of sediment. • Enhancing awareness about flood hazards and improving communications among local communities and government offices will improve flood warning toward evacuation. • Enhancing assessment about inundation patterns and improvement of the evacuation routes will increase safety during flooding.
Hazard increase by uncontrolled or excessive development	• Institutional arrangement for land use control and law enforcement will decrease uncontrolled or excessive development of the watershed and reduce soil erosion, sedimentation in the river bed, and sediment inflow to Lake Victoria. • Awareness-raising about negative impacts of deforestation and over-grazing and implementing alternatives will decrease soil erosion.
Lack of emergency flood fighting activities	• Enhancing knowledge and skills about flood fighting, such as trainings for temporary raising of levees by sand-bagging and emergency treatment of water leakage to prevent levee breaks, will improve flood fighting activities and decrease flood damage.
Hazardous geographical conditions	• Implementing structural measures for drainage in the low lying areas and restricting further residential development will mitigate flood damage. • Assessing the hazard of flash floods, disseminating the hazard information, and improvement of forecasting and warning of intense rainfall will mitigate damage by flash floods and debris flows in the hazardous areas.

Table 4.4 Changes in Social Weaknesses by Capacity Building in the Nyando River Basin

Subjects	Changes in Vulnerabilities
Less resilience for recovery from disasters	• Prioritize flood management by clarifying the causal relationship between the flooding and the local economy in the government will increase financial allocation for flood management throughout the flood management cycle. • Facilitating income generation of the local communities will increase resilience against flood damage.
Lack of knowledge, skills, and abilities	• Institutional arrangement clarifying authority and responsibility of government agencies regarding flood management will facilitate capacity building opportunities of relevant agencies. • Awareness-raising of the local communities will facilitate self-sufficient structural and non-structural measures of flood management.
Security problems	• Establishing measures to cover losses by thefts during evacuation, such as insurance or compensation by the government or community, will make evacuation easier during floods.

4.3 Evaluation of the Project Outcomes by Applying the Capacity Building Methodologies

This section evaluates the effectiveness of the project outcomes by the five evaluation criteria (relevance, effectiveness, efficiency, impact, and sustainability) of development projects summarized in **Table 1.4** when the capacity building methodologies are applied under climate change. The five evaluation criteria have been widely utilized since they were adopted in 1991 by DAC, OECD (DAC, 1991) to evaluate project outcomes during implementation stages or upon completion especially for projects supported by international donor agencies. **Section 4.3.1**

explains about the five evaluation criteria and **Section 4.3.2** applies the evaluation criteria to the project outcomes by applying the capacity building methodologies.

4.3.1 Evaluation Criteria

The five evaluation criteria consists of relevance, effectiveness, efficiency, impact, and sustainability as mentioned above.

Relevance is consistency between policies and needs of beneficiaries, namely relevance evaluates reasonability and necessity of flood management means to meet local needs. Flood management means are usually conducted following the government policies such as long term and middle term development plans. The policies sometimes differ from actual needs in local levels caused by difference in interests between the government and local community or changes of the needs due to the passage of time. Relevance is the key to secure collaboration between government organizations responsible for flood management, local communities, and other stakeholders toward effective flood management.

Effectiveness is how implementation of flood management means improved the situation to meet the objective of flood management. That is to say, how application of the capacity building methodologies contributed to reduce flood risks and negative consequences of flooding under climate change in this case. For example, effectiveness is measured by reduced

flood damage including reduced economic losses and casualties.

Efficiency mainly focuses on the relationship between the costs and benefits. Efficiency is determined by whether the investments, such as financial input, time, and human resources, to flood management means were reasonable compared to the project outcomes. Efficiency is evaluated by comparing quantity, quality, and timing of investment and the project outcomes. Efficiency is usually evaluated by comparing alternatives to achieve the same outcomes to see that the most efficient processes were taken.

Impact is mainly long-term direct or indirect influence of implementation of flood management means regardless of intended or unintended outcomes. The influence includes both positive and negative impacts, which were not necessarily expected in the beginning stages. Impact denotes higher levels of goals compared to the direct objective of flood management, such as economic development, social stability, and impacts on natural environment.

Sustainability is whether the benefits or outcomes of implementation of flood management means continue or not by self-help efforts. If continuous supports from outside sources such as international donor agencies are required, for example, to maintain or rehabilitate flood control structures, the flood management systems are not sustainable. Sustainability includes financial sustainability as well as environmental sustainability.

4.3.2 Evaluation of Project Outcomes

Application of the capacity building methodologies increases levels of all of the five evaluation criteria for implementation of flood management means under climate change as described in **Table 4.5**. The tables also show that comprehensive resources need to be mobilized and KSAs (knowledge, skills, and abilities) of people need to be developed to cope with the increased risks under climate change.

Case studies described in **Section 4.2** show that comprehensive capacity building is essential and effective to cope with increased flood risks under climate change. However, complexity of problems and levels of self-sufficiency regarding flood management differ between urban and rural areas regardless of the global necessity of capacity building for flood management systems. Urban areas require more comprehensive and inter-sectoral approaches to cope with increased risks as the individual capability influencing flood management is limited. In contrast, capacity building of people, such as awareness-raising and enhancing skills for construction of flood control structures, may directly mitigate flood damage in rural areas. This is caused by the more homogeneous society in rural areas compared to the mega cities in developing countries like Manila where social disparity is dominant. In either cases, application of the capacity building methodologies increases effectiveness of flood management under climate change.

Table 4.5 Evaluation of Project Outcomes by Five Evaluation Criteria, DAC, OECD

Criteria	Evaluation of Project Outcomes
Relevance	• Enhancement of community participation will facilitate consistency between the government polices and local needs. • Enhancement of information disclosure in its timing, quantity, and quality will give opportunities for extensive stakeholders to evaluate government policies.
Effectiveness	• Enhanced capacity to implement both structural and non-structural measures will reduce flood risks and negative consequences of flooding. • Enhanced capacity, such as improved analytical capacities and decision-making capacities, will contribute to adequate evaluation of increased flood risks under climate change and timely implementation of appropriate measures to reduce the risks.
Efficiency	• Enhancing capacity to select appropriate measures and technology to achieve the objective of flood management, such as the most efficient combination of alternatives, adequate decision-making for selection of technology to be adopted, and appropriate staffing, will improve efficiency. • Drills, training, and education of people will improve productivity, and as a result, also improve efficiency of flood management means.
Impact	• Decreasing flood risks and flood damage will vitalize economic activities and contribute to economic development. • Improving equity for allocation of flood management benefits, such as executing flood management means focusing on socially vulnerable groups, will contribute to stabilization of people's livelihood and society. • Awareness-raising of communities including adequate information disclosure will improve trust to the government and contribute to political stabilization. • Enhancing knowledge about the nature of flooding, such as perception about beneficial aspects of flooding, will contribute to environmental conservation.
Sustainability	• All institutional, organizational, and individual capacity building activities will facilitate self-help efforts and contribute to project sustainability. • Enhancing capacity for financial analysis will contribute to formulating and implementing financially sustainable measures. • Enhancing understandings about beneficial aspects of flooding will contribute to formulating and implementing environmentally sustainable measures.

Source: The evaluation criteria are from (DAC, 1991).

4.4 Flood Management Case Studies in the United States

This section describes the National Flood Insurance Program (NFIP) and the flood management in the Albuquerque urban area as flood management case studies in the U.S. These cases have been contributing all institutional, organizational, and individual capacity building and mitigation of flood risks and negative consequences of flooding. These cases accord with a number of elements of the formulated capacity building methodologies including the principles and the procedures. The lessons learned from these cases can be applied to developing countries.

4.4.1 National Flood Insurance Program

The NFIP is operated by the Federal Emergency Management Agency (FEMA). FEMA places the details of the flood insurance program on the web site including benefits, premiums, the latest dissemination rates, and payout records. The insurance is purchasable only for residents of municipalities, which applied enrollment to FEMA and passed the audit by FEMA. The premiums are not flat rates, but vary depending on levels of flood hazards shown in flood insurance maps published by FEMA. The premiums based on the levels of flood hazards and the disclosed flood insurance maps, which show locations with levels of flood hazards, contribute to restrict development of flood plains. In addition, the insurance has been functioning as incentives for implementation of flood management means by municipalities, because the insurance

premiums and subsidies from the federal government are determined depending on the progress of flood management means.

According to the web site of FEMA, the number of insured in the U.S. is about 5.6 million as of July 31, 2009. Although the number includes business establishments and apartments as well, it can be said that the dissemination rate is slightly over 5 % against the total households of about 100 million. The dissemination rate is high in Florida, Louisiana, and Texas, which are affected by frequent hurricanes. The number of insured in Galveston, Texas, where a large part of the city was devastated by Hurricane Ike in 2008, is 21,745 against the total households of 24,000, and the dissemination rate is about 90 %. The high dissemination rate is caused by the high interest in flooding by the communities as well as the insurance mandate for the loan terms of home mortgages in flood plains, and most areas in Galveston are designated as flood plains. In contrast, the number of insured, for example, in Fort Collins, Colorado located in the foot of the Rocky Mountains, is merely 430 against the total households of 45,000, and the dissemination rate remains as low as 1 %. The reasons of the low dissemination rate include that most parts of the city areas are not designated by flood plains, and therefore, the communities do not share the imminent threats of flooding, although the city also has suffered from severe flood damage in the past.

The community rating system (CRS) of the NFIP, started in 1991, provides incentives

for implementation of flood management means, which includes a discount of premium (45 % at the largest) and subsidies from the federal government as stated above. The premium is determined by zones categorized by levels of flood hazards. According to the official web site of the NFIP, the average annual premium is US$540 per case. The above mentioned City of Fort Collins has been implementing proactive flood management means, both in structural and non-structural measures, especially since the severe flood damage in 1997, and the discount rate of the insurance premium is 30 % as of 2010, which was determined by the audit by the FEMA based on the flood insurance study and the CRS study.

The total claims of the NFIP from January 1, 1978 to July 31, 2009 are about 1.3 million cases and US$37 billion, namely the average insurance benefit per case is about US$28,000. Florida, Louisiana, and Texas occupy the largest part of the claims as well as the number of insured caused by the larger flood damage due to the frequent attacks of hurricanes.

The institutions of the NFIP have been inspiring capacity building of municipalities and local communities through the incentives determined by the score of CRS. The NFIP is an example of institutional capacity building, which facilitates both organizational (municipalities) and individual (officials in the municipalities and the local communities) capacity building. As a result, the NFIP has been facilitating implementation of both structural and non-structural measures for all preparedness, responses, and recovery. The flood insurance, such as the

mechanism of the NFIP, can be one of flood management alternatives, also in developing countries, to reduce flood risks and negative consequences of flooding through capacity building.

4.4.2 Flood Management in the Albuquerque Urban Area, New Mexico

The Albuquerque urban area is the economic center of the State of New Mexico. Historical records show that floods on arroyos in the Albuquerque urban area caused extensive damage. Much of Albuquerque's past flood damage has been due to inundation in the low-laying areas adjacent to the Rio Grande. Albuquerque is located at the foot of the Sandia Mountains and flood water is drained by arroyos as shown in **Figure 4.1** and the photos in ***APPENDIX***.

Floods in the Albuquerque urban area are most frequent during July and August, when severe thunderstorms produce the high runoff that characterizes flash floods in the Southwest of the U.S. Such floods often strike with devastating swiftness down normally dry arroyos. Albuquerque has a flood control special district, which is called the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA), as seen in other major U.S. urban areas. The AMAFCA has been promoting construction of flood control structures. Moreover, Albuquerque is recognized as one of the most advanced cases of its proactive preparedness against climate change according to "Climate Resilient Cities" (World Bank, 2008a).

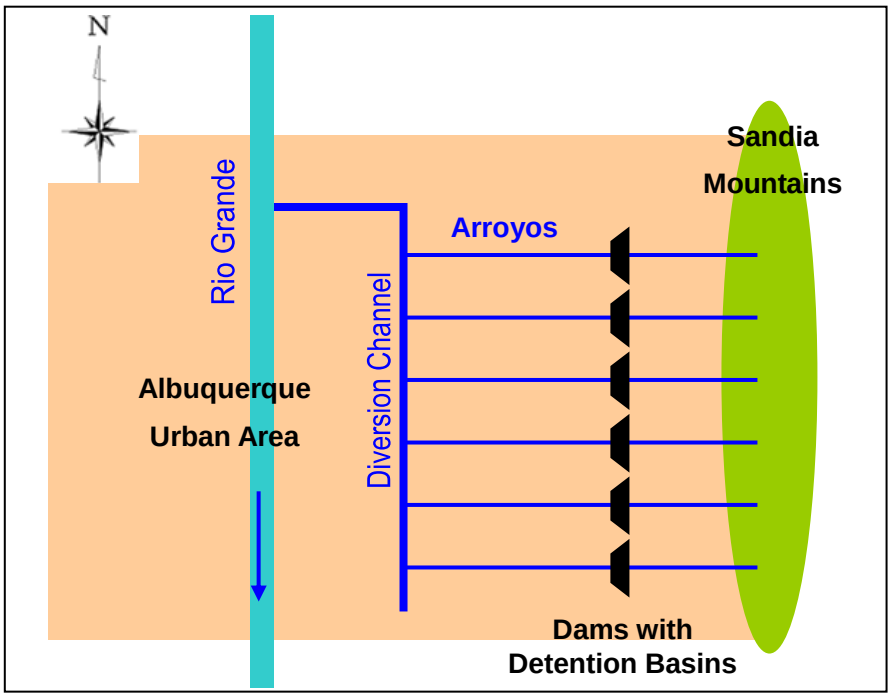


Figure 4.1 Schematic Diagram of Drainage Systems in Albuquerque

The AMAFCA was established in 1963 by the New Mexico Legislature with specific responsibility for the flooding problems in the Albuquerque area. The AMAFCA decided that drainage planning should precede the planning for other urban systems (utilities, recreation, etc.). A master drainage plan was established afterwards to utilize as much land as possible with a minimum of alteration to the natural characteristics of the area (Bishop, 1978).

Flood control facilities in the Albuquerque urban area have been constructed and managed not only by the AMAFCA, but also by Albuquerque/Bernalillo County Water Utility Authority (ABCWUA), Middle Rio Grande Conservancy District (MRGCD), Bernalillo County

(BC), City of Albuquerque (COA), New Mexico Department of Transportation, and United States Forest Services (USFS), depending on location and drainage purposes.

Main activities of the AMAFCA are construction and maintenance of the flood control structures. The AMAFCA has been constructing and managing dams to store flash flood water temporarily and arterial drainage channels[11] to drain water rapidly to the Rio Grande. In addition, the activities include technical review of land use development by any governmental or private bodies influencing flood run-off. The regulation (AMAFCA, 1980) imposes the developers to submit the following documents for the review and approval by the AMAFCA:

- A contour map of the lands under consideration prepared under the direction of and signed by a registered surveyor or professional engineer
- A drainage report and plan prepared under the direction of and signed by a registered professional engineer
- A written agreement between the owner of the lands being platted or developed, and the Authority, that no grading, filling, excavating, or other alteration will be performed

In addition, the activities of the AMAFCA include public relations about flood management

[11] The two large scale North and South Diversion Channels were built by the Army Corps of Engineers and the AMAFCA was the local sponsor for the construction. The AMAFCA is responsible for maintenance of the channels. The territory of the AMAFCA at present includes not only the foot of the Sandia Mountains, but also the right bank of the Rio Grande.

activities. The AMAFCA focuses on school children for the campaign, which explains the threats of flash floods and function of the flood control facilities. The AMAFCA is also distributing free swimming pool tickets to the school children not to play in the flood drainage channels. These activities have been enhancing awareness of the local communities about flood management and the role of the AMAFCA.

The Emergency Management Office (EMO) is responsible for disaster management in the City of Albuquerque. "A Strategic Guide for the City-Wide Response to and Recovery from Major Emergencies and Disasters" (City of Albuquerque, 2005) describes preparedness, responses, and recovery regarding disaster including flooding.

FEMA, using the model created by the Los Angeles City Fire Department, began promoting nationwide use of the Community Emergency Response Team (CERT) concept in 1994. The CERT program educates people about disaster preparedness for hazards including flooding that may impact their area and trains them in basic disaster response skills. Following the efforts by the city offices including the EMO and volunteers, the first Albuquerque CERT class was held in 2006. The number of people who completed the class is increasing to implement the neighbor-helping-neighbor approach.

Albuquerque has been known as one of the most advanced cases in the U.S. to cope with climate change as stated above under strong leadership of the former mayor. The city has

comprehensive mitigation and adaptation programs named "Albuquerque Green", which aim to reduce negative impacts of climate change including the increasing threats of flooding by a no-regrets approach. The program promotes physical measures along with partnership and collaboration, including emergency operations, community volunteers, and disaster risk management.

The flood management practice in the Albuquerque urban area suggests the following:

- The activities of the AMAFCA have been contributing all of institutional, organizational, and individual capacity building for effective flood management and reduced flood damage. Establishment of a special purpose agency, such as the case of the AMAFCA, contributes to promote construction of flood management infrastructure, prevent uncontrolled development, and enhance awareness of the community.
- Establishment of special purpose agencies may contribute to reduce flood risks in developing countries effectively, where flood management problems are still dominant due to insufficient institutional, organizational and individual capacities including lack of inter-sectoral cooperation as observed in the case studies in Jakarta, Indonesia (**Section 2.4.1**) and Manila, the Philippines (**Section 3.2.1**).
- Participation of local community such as the CERT program may enhance people's awareness about disaster management and increase resilience to flood damage.

- Proactive preparedness against climate change such as the Albuquerque Green program may decrease vulnerability to flood damage under climate change. Strong leadership and decision-making capacity is required to implement the program.
- Many of the comprehensive measures and approaches taken in Albuquerque can be applied to or serve as references in developing countries.

4.5 Sample Terms of Reference of Flood Management Study

The formulated capacity building methodologies can be applied in flood management practices throughout the flood management cycle. However, it is more effective if the methodologies are incorporated in a form of terms of reference (TOR) of each flood management project that stipulates objective and scope of works of the project. This section shows sample TOR of a hypothetical flood management study; “Study on Flood Management in the A River Basin in Country B”, incorporating the formulated capacity building methodologies by speculating a river basin in a developing country.

The conceptual model of capacity building for flood management shown in **Figure 2.15** can be utilized during the study to identify elements of flood management systems, their interrelationship with capacity, and to measure capacity that influences effectiveness of flood management systems. The checklist for the capacity building procedures shown in **Table 3.10**

can be utilized for performance assessment in the study. Checklists are often utilized in modern management. Moreover, the other tools introduced in the research, including the indicators to measure a level of uncertainty as applied in **Section 3.6.1** and the five evaluation criteria of development projects as applied in **Section 4.3**, also can be utilized to evaluate study output.

4.5.1 Background of the Study

The A River Basin with the area of 10,000 km^2 has a population of ten million. City X, which constitutes the second largest urban area in Country B and is located in the flood plain of the river basin, suffers from frequent floods. Flood control infrastructure in the river basin has been constructed, operated, and maintained by the central and local government agencies. However, flood damage, both casualties and economic loss, has been increasing especially in the recent 10 years following the rapid development of the upper watershed, urbanization of the X urban area, and the increased rainfall intensity, which is suspected as an influence of climate change.

Under the circumstances, Country B determined to carry out a study to formulate a flood management master plan in the A River Basin aiming at flood damage mitigation, economic development of the area, and improvement of public welfare as a result of enhanced flood management.

4.5.2 Objective of the Study

The objective of the study is to formulate a flood management master plan of the A River Basin with a target year of 2030. The plan will comprise of a strategy and institutional framework for sustainable development of the basin; long-term (20 years) investment programs; and financial and institutional arrangement plans. The plan will focus especially on enhancement of institutional, organizational, and individual capacities to cope with the increasing flood threats under climate change.

4.5.3 Scope of Works for the Study

The scope of works for the study consists of (1) Identification of resources and constraints for flood management, (2) Formulation and prioritization of flood management alternatives, and (3) Establishment of implementation plans of the priority projects as shown below. The entire study processes will be carried out through stakeholder participation along with appropriate information disclosure.

(1) Identification of Resources and Constraints for Flood Management

The study will indentify the following resources and associated constraints for flood management in the A River Basin and clarify the factors amplifying the flood damage:

- Relevant laws and regulations

- Stakeholders including communities, government agencies, NGOs, and private sectors
- Inter-connectivity and interdependence of sectors in flood management
- Social, environmental, and cultural background regarding flood management
- Hydrological and meteorological data required for flood management planning
- Land use of the A River Basin including upper watershed, middle reaches, and the flood plains
- Flood management infrastructure and other physical resources including their operation and maintenance
- Financial resources
- Human resources (KSAs; knowledge, skill, and ability)
- Other relevant information

(2) Formulation and Prioritization of Flood Management Alternatives

The study will formulate and prioritize flood management alternatives based on the identified resources and associated constraints as follows:

- Establish a stakeholders' working group, which discusses and determines the flood management alternatives
- Disclose the relevant information to the local communities by accessible means

- Estimate external forces and magnitude of flooding including inundation areas and depth taking account of climate change
- Estimate social, environmental, and economic impacts of the flooding
- Formulate flood management alternatives including both structural and non-structural measures
- Determine criteria for prioritization of the flood management alternatives
- Prioritize the flood management alternatives

(3) Establishment of Implementation Plans of the Priority Projects

The study will establish implementation plans of the priority projects and necessary human resources development as follows:

- Establish implementation plans of the priority structural and non-structural measures, which include financial and institutional arrangements
- Assess educational needs for implementation of the priority flood management measures
- Establish implementation plans of human resources development taking account of identified incentives, which include drills, OJT and Off-JT, awareness-raising, and stakeholder participation.

CHAPTER 5

CONCLUDING REMARKS

5.1 Introduction

Although climate change effects will pose new flood threats to developing countries, a number of constraints are preventing flood management improvements. The disparities between developed and developing countries might become greater under the increased flood threats induced by climate change unless appropriate and timely measures are implemented. The research clarified how to apply capacity building to respond to an ongoing paradigm shift and secure the integrity of flood management systems in developing countries.

The research clarified how capacity building reduced flood risks and the accompanying negative consequences of flooding under climate change. It utilized a conceptual model to identify capacity-related flood management problems and their interrelationships and to clarify needs for capacity building at institutional, organizational, and individual levels throughout the flood management processes. Then, the research established and tested capacity building methodologies, which consist of principles and procedures to implement the principles.

5.2 Summary of Research Outcomes

Figure 5.1 summarizes the research justifications and hypotheses (**Chapter 1**) and the outcomes of the research (**Chapters 2 - 4**).

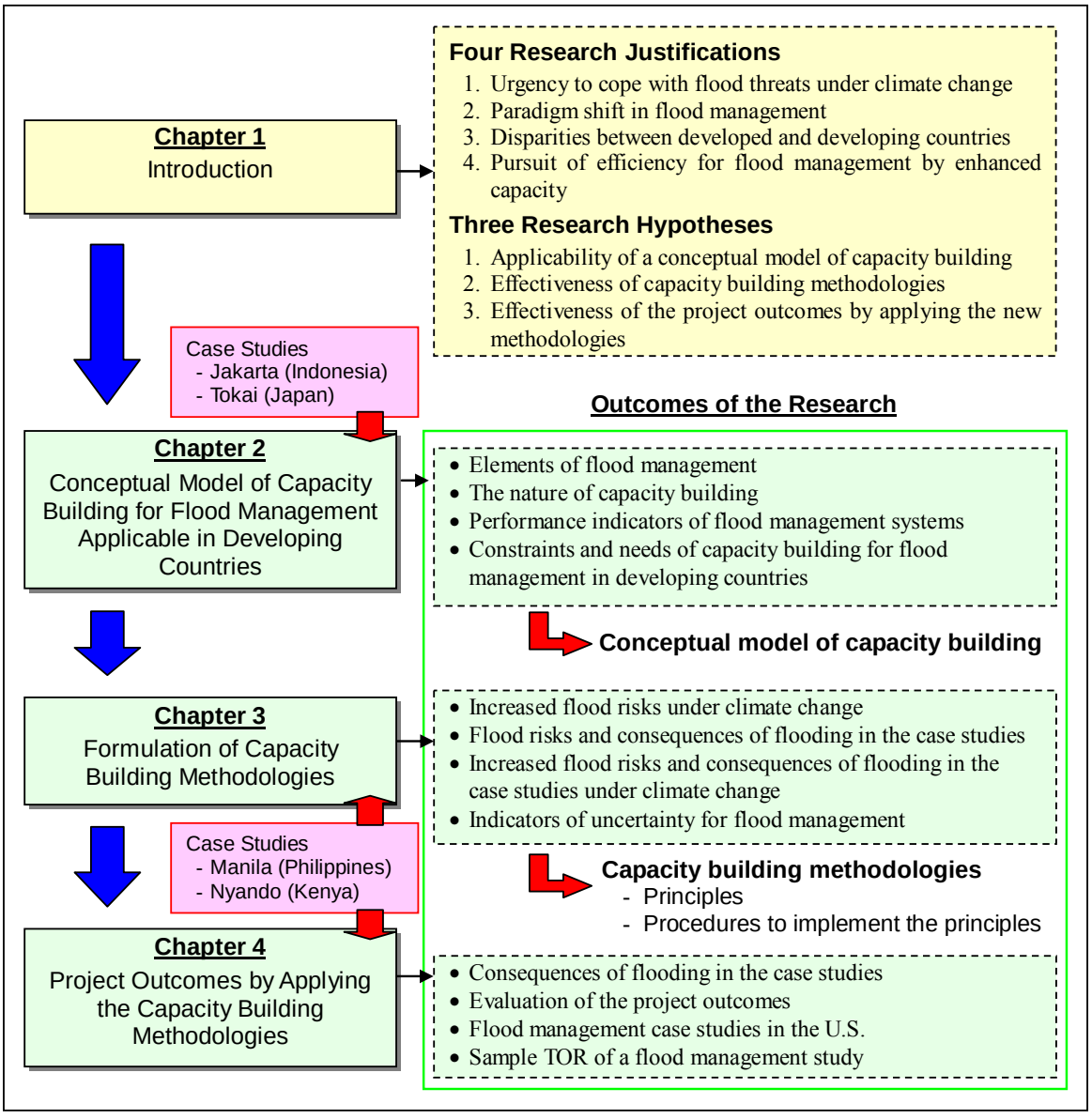


Figure 5.1 Research Justifications, Hypotheses, and the Outcomes of the Research

The objective of the research was to formulate and test capacity building methodologies to enhance flood management in developing countries under climate change. The following problem justification led to the research objective:

First, the research defined the problems under climate change by the 'three Vs'; volatility, vulnerability, and vigilance. Volatility, caused by rapidity, uncertainty, and complexity of climate change, amplifies the existing vulnerability. The vulnerability forces the society to exercise vigilance. The research clarified how to exercise vigilance by establishing robust flood management systems through capacity building.

The research, then, clarified the paradigm shift in flood management comparing the traditional and new contexts. The paradigm shift is followed by the changing context including progress of democratization, diversification of people's sense of values, rapidly growing population and associated excessive development, concentration of populations into urban areas, and more emphasis on environmental conservation. The traditional flood management is defined by the simple causes and consequences of flooding and the resulting simple solutions by top-down approaches. Required approaches under the new context are more comprehensive, interdisciplinary, future oriented, anticipatory, participatory, bottom-up, and integrated.

The research also clarified problems regarding the disparities between developed and developing countries, which included insufficient infrastructures, lack of legislation and

enforcement programs, and other institutional and socioeconomic constraints in developing countries. The research, then, pointed out the probability that the increased flood risks under climate change added to the paradigm shift may complicate the problems and solutions, and accelerate the disparities between developed and developing countries

Finally, the research pointed out a trade-off relationship between the complicated requirement for flood management under climate change in the context of the paradigm shift and the urgency to cope with flood risks in developing countries.

The following three research hypotheses were established to test applicability and effectiveness of the research output:

Hypothesis 1: Applicability of a Conceptual Model of Capacity Building

If we apply a conceptual model of capacity building for flood management, we can readily evaluate flood severity, consequences of flooding, and their relationship with flood management systems since the conceptual model is supported among extensive stakeholders. This hypothesis was proved in **Chapter 2**.

Hypothesis 2: Effectiveness of the Capacity Building Methodologies

If we conduct flood management projects following the capacity building methodologies, we can decrease uncertainty in flood management under climate change since the methodologies are supported by executing and donor agencies. This hypothesis was proved in **Chapter 3**.

Hypothesis 3: Effectiveness of the Project Outcomes by Applying the New Methodologies

If we implement flood management projects which apply the methodologies meeting Hypotheses 1 and 2, the projects will effectively mitigate the flood risks under climate change and contribute to economic development in developing countries. This hypothesis was proved in **Chapter 4**.

These hypotheses were proved by analyzing case studies listed in **Table 5.1**.

Table 5.1 Flood Management Case Studies to Prove the Hypotheses

Case Studies	Major Floods	Remarks
Hypothesis 1		
Jakarta, Indonesia	January 2002, February 2007	Jakarta is suffering from floods every year. Jakarta is a typical large city in developing countries which is vulnerable to floods, e.g. rapid urbanization in flood plains, and complex problems with economic, social and political aspects.
Tokai Region, Japan	September 2000, August 2008	The 2000 flood had a large impact on Japanese flood management because of the unexpected rainfall intensity and magnitude of damages. Lessons learned and measures taken after the flood can represent cases in developed countries.
Hypotheses 2 and 3		
Manila, Philippines	August 1999, September 2009	Manila like Jakarta also has typical characteristics as a large city in developing countries. Manila experienced severe flood damage in September, 2009.
Nyando, Kenya	December 2006	The Nyando river basin, with agriculture as the primary industry, has typical characteristics of rural areas in developing countries. Pilot flood management projects taking climate change into account have been implemented in the area.

The processes of capacity building were framed in terms of four questions: how do we change the inappropriate flood management systems; how do we mobilize resources; how do we bring the resources together; and how do we educate people? Then, performance indicators were utilized to interpret individual, organizational, and institutional capacity levels required for effective flood management. The effectiveness of institutions was measured by laws and regulations and operational organizations. The effectiveness of infrastructure was based on capital assets and the processes of planning, design, operation, and maintenance, which are performed by the operational organizations. The degrees of awareness and participation by the local community were shown by how the local community is influenced by flooding and influences the political processes of flood management. Finally, data availability is needed to support decision-making of the flood management systems.

The case studies in Jakarta and Tokai showed that:

- Institutional supports are essential for effective flood management. At the same time, the effectiveness of flood management depends on the capacity to implement the institutions.
- Infrastructure mitigates flood damage effectively if it is appropriately designed, operated, maintained, and the limitations of infrastructure are recognized.
- Awareness regarding flood threats and flood management by the local community

based on information disclosure and participation is a key issue to mitigate flood damage.

- Data availability, quality, and accessibility are fundamental to the flood management processes.

The research established the conceptual model to:

- Identify the problems and their interrelationships in a comprehensive manner.
- Clarify the needs for capacity building in institutional, organizational, and individual levels throughout the flood management processes.

The case studies in Manila and the Nyando river basin led to the following four principles of capacity building for flood management in developing countries under climate change:

1. The capacity to implement both structural and non-structural measures need to be developed.
2. All institutional, organizational, and individual capacity is crucial.
3. Leadership and decision-making capacities are more required under increased flood risks.
4. The capacity to secure the 'three Es' (effectiveness, efficiency, and equity) is the key to increasing feasibility of flood management means.

The capacity building procedures to implement the principles are answers to the three questions mentioned above: 1. How do we mobilize resources?; 2. How do we bring the resources together?; and 3. How do we educate people? In other words, they are 1. The processes of capacity assessments, 2. Integration of resources including formulation and prioritization of alternatives and implementation of priority measures, and 3. Human resources development to make the most use of resources. The research offered a checklist as a tool to verify integrity of capacity building procedures.

Finally, the research verified the effectiveness of project outcomes by applying the capacity building methodologies to same case studies in Manila and the Nyando river basin. The case studies showed that:

- Inter-sectoral cooperation becomes increasingly required under escalated flood threats induced by climate change especially to respond to complex urban problems.
- Awareness-raising of communities and more involvement of government agencies will improve the quality of flood management practices significantly especially in rural areas in terms of transfer of knowledge and technology assessment.
- Urban areas require more comprehensive and inter-sectoral approaches to cope with increased risks as the individual capacity influencing flood management is limited.
- Capacity building of community people directly mitigates flood damage in rural areas.

- Application of the capacity building methodologies improves relevance, effectiveness, efficiency, impact, and sustainability of project outcomes.

5.3 Overall Conclusion and Recommendations

The context surrounding public policy is changing globally due to democratization, diversification of people's sense of values, and high rates of development due to population growth. The new contexts in flood management include:

- Structural measures are no longer the preferred solutions, and integration with non-structural measures is required to minimize flood damage.
- Catastrophic damage including loss of lives needs to be avoided in case of extreme flood events exceeding the design flood levels.
- The entire flood management cycle including preparedness, responses, and recovery needs to be considered in a balanced manner for realizing the robust society.

The new context arose from the fact that the traditional flood control based on top-down structural measures did not necessary mitigate flood damage. Not only the traditional flood control did not decrease social volatility and vulnerability, but also it sometimes caused catastrophic damage due to failure of the existing structures.

In addition to the paradigm shift, climate change amplifies the complexities of flood

management processes due to the increased risks and uncertainties. Besides, problems in developing countries are more complex and intertwined compared to developed countries. Superior infrastructure, fundamental laws, and human resources are becoming available in many developing countries. However, flood threats are still increasingly enlarged and the resulting volatility and vulnerability is interrupting social stability and economic growth in developing countries.

The escalating flood threats are caused by a number of factors harming the integrity of flood management as a system. The research focused on inadequate capacity in developing countries that harms the integrity and attempted to clarify elements of the flood management system as well as their interrelationship with capacity. As a result, the research proposed the capacity building methodologies in order to cope with increased flood threats under climate change. The methodologies were characterized by the following capacity building goals as reflected in the four principles:

- Development of capacity to implement and coordinate structural and non-structural measures,
- Integration of all institutional, organizational, and individual capacities,
- Enhancement of leadership and decision-making capacities, and
- Improvement of the 'three Es' (effectiveness, efficiency, and equity).

Since the research involves a broad range of factors regarding flood management, the research outcomes tended to be abstract and general, although the author tried to describe the processes to lead to the outcomes concretely with the analysis of the flood management case studies in Indonesia, Japan, the Philippines, Kenya, and the U.S. Interpretation and application of the research outcomes may vary depending on location, natural and social environment, cultural background, and political systems. In addition, senses of value may change as time goes on and the advance of science as the paradigm shift shows. Therefore, the research outcomes need to be tested, monitored, and modified by applying them to each flood management case.

For example, in the case of Manila, awareness-raising program of the local community needs to be tested, monitored, and modified from the following viewpoints:

- Does the community really understand the information regarding flood hazards? Is the flood hazards information reliable, helpful, and accessible?
- Does the community really understand the consequences of solid waste disposal to the waterways? Is the explanation technically justified?
- Do the relevant government agencies (e.g. DPWH, MMDA, NHA, and LGUs) share the information and face in the same direction regarding the awareness-raising program of the community? Are the flood management measures executed by the agencies are accountable, sustainable, and meeting the 'three Es' (effectiveness, efficiency, equity)?

- Do the relevant institutions work as incentives for the local community to facilitate leadership for flood management measures?

Capacity building has been one of the most important objects of international cooperation projects. This happened because people realized the limited effects of the projects or sometimes the counterintuitive effects resulted in negative impacts on flood management as a system when the efforts were concentrated to solve specific problems. However, it was not easy to identify how to implement capacity building in flood management practices because of the complexity of flood management systems. In retrospect, the author hopes that the research will contribute to clarifying flood management systems and improving processes of planning, implementation, and evaluation of capacity building programs for flood management in developing countries, especially in the context of increased complexities and uncertainties of climate change.

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APPENDIX

Photos in the Albuquerque Area (February 2010)

Albuquerque City Located on the Foot of Sandia Mountains

AMFCA Office

North Diversion Channel with a Bike Road

North Diversion Channel (Confluence of Enbudo Channel)

North Diversion Channel (Alameda Blvd)

Sign Board of AMFCA

North Diversion Channel
(Near Confluence of Rio Grande)

North Diversion Channel
(Near Confluence of Rio Grande)

Piedra Lisa Dam (Managed by the City of Albuquerque)

Piedra Lisa Park
(The park works as a detention basin.)

Piedra Lisa Arroyo
(A natural arroyo downstream of the park.)

South Domingo Baca Dam
(Managed by AMAFCA)

South Domingo Baca Dam
(Managed by AMAFCA)

Rio Grande Flowing the City of Albuquerque (From Alameda Blvd)

Alameda-Rio Grande Wetland
(Alameda Rd Detention Pond)

Alameda-Rio Grande Wetland
(Alameda Rd Detention Pond)

Alameda Pump Station

Albuquerque River Side Drain
(Managed by MRGCD)

Mariposa Detention Basin Managed by the City of Albuquerque
(Utilized as a sports ground.)

Ladera Dam Managed by AMAFCA
(Utilized as a golf course.)

Ladera Dam Managed by AMAFCA
(A sign board at a flood water course.)

Ladera Golf Course
(The golf course is managed by the City of Albuquerque.)

Ladera Dam System Managed by AMAFCA
(Adjacent to a residential zone.)

Ladera Dam System Managed by AMAFCA
(Consisting of 15 dams.)