Handbook on Climate Change Adaptation in the Water Sector

A Resilient Approach that Integrates Water Management and Community Development

March 2010
Japan International Cooperation Agency
Global Environment Department

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Summary

It is predicted that climate change will increase the intensity and frequency of floods and droughts with its impacts more severely felt in developing countries. A fundamental review of development assistance approaches is required in the water sector. This handbook provides a new approach to formulating and implementing projects for climate change adaptation.

For the future, development interventions should meet the following requirements:

1. Dealing with a changing climate
2. Formulating and implementing projects while projecting future impacts, and
3. Adjusting water management systems to reflect day-to-day progress in technologies available for projection and adaptation.

Chapter 1 sets out the five basic concepts for **an approach to coping with a changing and uncertain climate resiliently and sustainably**:

1. **Human security**: Focusing on individuals, particularly the most vulnerable, as well as on the overall cost-effectiveness of a project
2. **Engagement with the society**: Engaging with the society as a whole, including informing and influencing local government heads and central government policymakers
3. **Building a sustainable adaptive society**: Building a sustainable society that can resiliently cope with a changing climate whose prediction entails uncertainty
4. **Disaster risk management**: Managing disaster risks with the focus on the society's vulnerabilities, especially those associated with urbanization, and adaptive capacity
5. **"Zero victim" goal of flood control**: Taking a three-tier adaptive approach: (i) protecting critical areas using structures, (ii) discouraging settlement in disaster hazard areas, and (iii) coping with unavoidable inundation with community-based disaster management

Chapter 2 introduces **methods for forecasting extreme events such as floods and droughts**. The outputs of global climate models are available for projecting future precipitation. This chapter also explains how to use this data in formulating a project and handling projecting uncertainties.

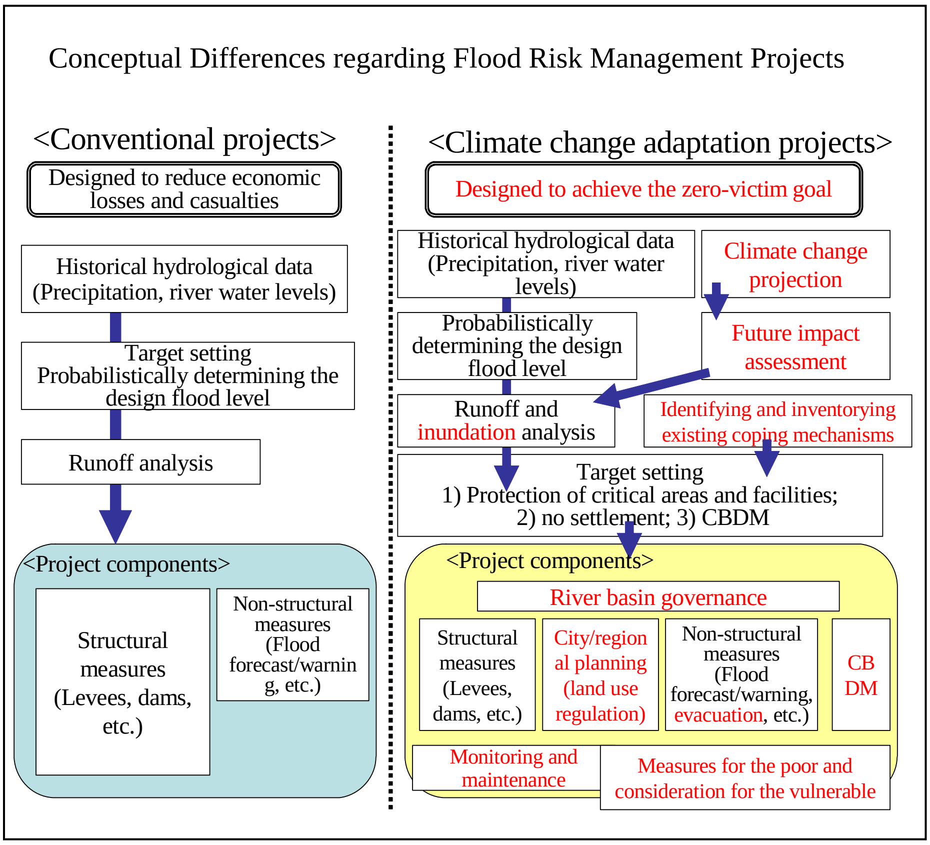
Chapter 3 introduces **analytical methods for assessing damage and impacts**. It also discusses approaches required for setting the target years and projecting precipitation and atmospheric phenomena in the target areas, existing mechanisms, and impact assessment methods.

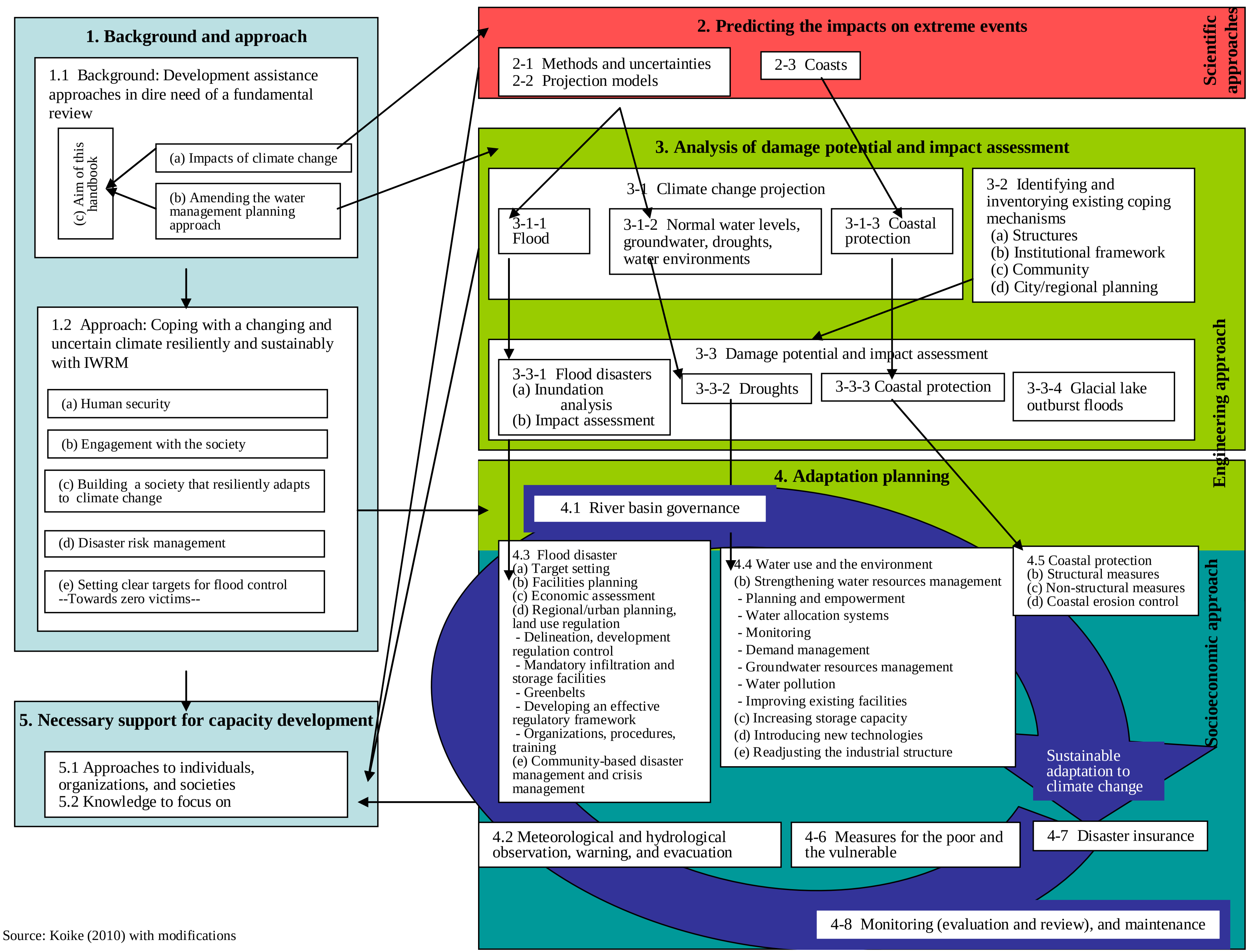
Chapter 4 focuses on **adaptation planning methods**. Because adaptation measures involve a wide range of stakeholders and sectors, the first step to be taken is to strengthen river basin governance through, for example, establishing a basin council.

- **Flood control**: In the face of ever-increasing floods, it is no longer practical to contain them in the river areas. The basic principle is to refrain from constructing continuous levees that may not prove effective unless they run all the way from the upstream mountainous area to the estuary. **Multilayered approaches should be taken throughout the basin** to cope with overflowing water, including land use regulation and community-based disaster management (CBDM).
- **Water use and the environment**: **Strengthening integrated water resources management** to cope with a changing climate
- **Coastal protection**: Interventions should be studied carefully due to the high costs and projection challenges associated with structural measures.

This chapter also discusses considerations for the poor and the most vulnerable, disaster insurance, and monitoring/maintenance as cross-sectoral interventions.

Chapter 5 explains the need for **capacity development so that developing countries will be able to better cope with climate change and technological development**.





Source: Koike (2010) with modifications

Task Force on the Handbook on Climate Change Adaptation in the Water Sector

To help formulate this handbook, JICA set up a study committee of external experts and academics as follows:

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This handbook has been compiled by the JICA Task Force on Water Resources and Disaster Management; it does not necessarily reflect the official views of JICA.

Contents

1. Background and Approach

1-1 Background: Development Assistance Approaches are in Dire Need of a Fundamental Review

(a) Impacts of climate change

The impacts of climate change on the water sector are so substantial that they cannot be disregarded and require a fundamental review of conventional development assistance approaches. The IPCC Fourth Assessment Report predicts that as a result of climate change, freshwater resources will decrease by 10 to 30 percent in many mid-latitude and tropical dry regions, and that the projected sea-level rise by the 2080s will result in millions more people experiencing flooding every year.[1]

Developing countries are particularly vulnerable to these climate change impacts.[2] It is estimated that they will bear most of the costs of the changing climate, with South Asia and Africa experiencing reductions in GDP of 4 to 5 percent.[3] Developing countries in Asia and the Pacific are highly sensitive to climate variability due to their geographical conditions, such as the existence of deltas, low coral reefs, and cyclone-prone areas, thus it is feared that their vulnerability will increase as their economies grow.[4,a]

(b) Amending the water management planning approach

Since stationarity is no longer a viable concept, radical amendments to conventional planning for water management are required.[5,6] Historically, flood control and water resources management has been planned based on the premise that past precipitation pattern will not change over time [stationarity]. Applying the existing approach without considering climate change impacts could lead to under- or over-design, resulting in either inadequate performance or excessive costs.[7]

For the future, the project formulation approach will be fundamentally different from the conventional one in the following aspects:

- ✓ It will deal with a changing climate.
- ✓ It will involve projecting future impacts for project formulation and implementation.
- ✓ Technologies available for projection and adaptation are developing from day to day, and water management systems will change or must be changed accordingly.

(c) Aim of this Handbook

Climate change adaptation in the water sector is an uncharted area, and there are no

[a] Key sources of references is:

Panel on Infrastructure Development, Japanese Government. *Climate Change Adaptation Strategies to Cope with Water-related Disasters due to Global Warming (Policy Report)*
http://www.mlit.go.jp/river/basic_info/english/climate.html

established planning methods. The Ministry of Land, Infrastructure, Transport and Tourism, Japan is currently preparing "Guidelines on climate change adaptation planning for water-related disasters." This handbook is aimed at translating these guidelines into practical directions for specific projects. To this end, it sets out JICA's policy on putting capacity development and adaptation into action in the field.

The handbook mainly covers flooding, for which conventional measures are increasingly found to be inadequate and on which knowledge is being accumulated. Water resources management, water environments, sediment, and coasts are also included.
This handbook will be updated as appropriate, since this sector is one in which technological development is rapid and the accumulation of experience is lacking. The next update is scheduled for March 2011.

1-2 Approaches

(a) Assistance that puts people at the center of concerns and that effectively reaches the people: from the perspective of human security

"Human security" is defined as "protecting people from critical and pervasive threats and situations, building on their strengths and aspirations."[8] The idea is to place individuals at the center of concerns and protect them from the threat of a "fear" of natural disasters and of "want" resulting from a lack of social services and basic infrastructure, and also to support their capacity development with a view to building a society in which everyone can live with dignity. As part of its efforts to protect the socially vulnerable, JICA supports the empowerment of societies and organizations and development of the capacity of individuals to cope with the threats to which they are exposed.

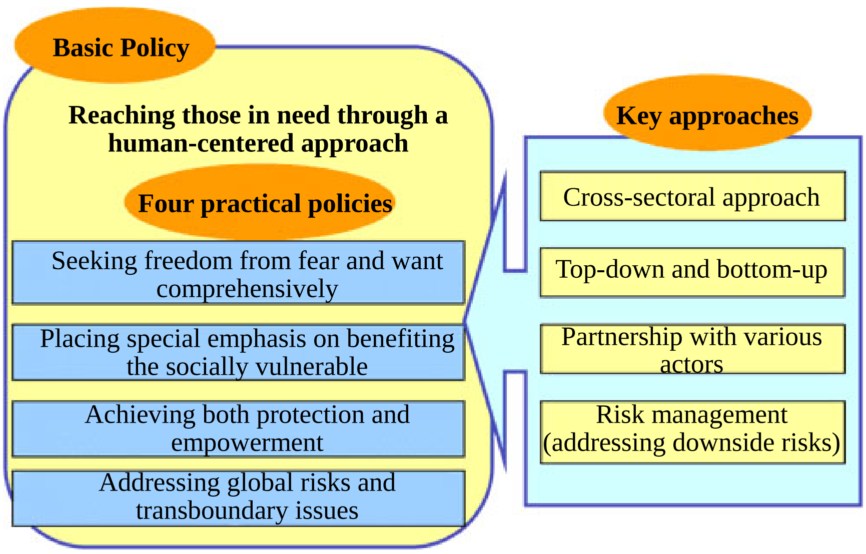


Figure 1 Human Security (Source: JICA Website, with modifications)

In implementing water sector projects, special attention should be paid to individuals, especially those who are the most vulnerable. Historically, such projects have been evaluated based on the aggregation of a number of indicators, including the reduction of damage, the population protected from inundation, and the population with access to water. In this process, the diversity of the society, especially of individuals, has been disregarded. For example, the urban poor living in a riverbed area may have been regarded as among those requiring relocation as part of the costs of a flood control program, but have rarely been thought of as the people who are actually the most vulnerable to floods.

The inundation of the floodplain should be allowed in adapting to more frequent and intensive floods due to climate change. Adaptation project planners therefore need to consider the diversity of the local communities affected. They should turn their attention to the most vulnerable, including the poor, and design projects to accommodate the diversity of society, including examination of the impact on poverty reduction.

(b) Engagement with the society

Engagement with the society, including informing and influencing local government heads and central policymakers, is the key to mainstreaming adaptation in development policies. It is important to build a broader mechanism for this purpose, in addition to formulating and implementing individual projects involving science and technology, notably those for technology transfer and facility construction.

Enabling people to feel safe and secure with regard to natural disasters calls for three essential elements: (i) "public help," or government efforts to manage disasters, which should be strengthened; (ii) "self-help" or efforts by individuals, businesses and other entities on their own; and (iii) "mutual help" or efforts by local communities, businesses, and organizations to help one another; this also calls for coordination among these three elements.[9] These three elements plus assistance from other countries can be summarized in Table 1.[10]

Table 1 Public Help, Mutual Help, Self-Help, and Foreign Help[10]

Type of help	Definition
◆ Public help	Responses by central and local government
◆ Mutual help	Support by community-based organizations, consanguineous groups, faith-based organizations, which are all situated between the public and private spheres, and by intermediate organizations of citizens
◆ Self-help	Preparedness by households and individuals
◆ Foreign help	Support from other countries

(Source: JICA (2003). *Bosai to Kaihatsu: Shakai no Bosairyoku no Kojo wo Mezashite [Disaster Prevention and Development: Working to Improve Society's Disaster Management Capacity])*

(c) Building a society that resiliently adapts to climate change

The climate will continue to change in the future. No climate change projection will ever be free from uncertainty. It is essential to build a resilient society that can sustainably adapt to such a changing and uncertain climate. To this end, integrated water resources management (IWRM) should be strengthened further.

Climate change will have complex and multidimensional implications for the water cycle, water use, and floods. Comprehensive and integrated actions are required with attention given to (a) all water-related subsectors, including flood management, water use, and water environments; and (b) stakeholders at all levels, including central and local governments, the private sector, NGOs and local communities. Such action should be reviewed as appropriate to better cope with a changing climate. This process is consistent with IWRM, an approach that has been advocated since the 1990s; it even highlights the need for IWRM more than ever.

Moreover, climate change calls for a transition from following the traditional practices of economic growth and development, which build on the idea that economic development entails increases in greenhouse gas emissions and environmental loading, to building a “low-carbon” and “sound material cycle” society, which promotes economic activity and at the same time reduces greenhouse gas emissions while respecting environmental conservation and the effective use of natural resources.[11] In other words, what is required is long-term sustainable development that incorporates climate change adaptation. A society’s vulnerability will depend not only on a changing climate, but also what type of development will be pursued. It is essential to pursue environmental conservation and development in tandem and put into action the principle of sustainable development that “meets the needs of the present without compromising the ability of future generations to meet their own needs.”[12]

(d) Disaster risk management

Disaster risk is expressed in the following formula[13]:

$$\text{Risk} = \frac{\text{Hazard} \times \text{Vulnerability}}{\text{Capacity}}$$

The hazards will increase when extreme events that cause floods, sediment-related disasters, droughts, storm surges, and other adverse conditions increase in intensity and frequency and the sea level rises. The vulnerability of a society increases with the concentration of the population in cities and the settlement of the poor in areas of risk such as riverbed areas and steep slopes. Reducing such risks requires strengthening the society’s disaster management capacity. Historically, the main focus has been placed on mitigating hazards. For example, levees have been constructed to reduce flood inundation. The emphasis should also be placed on reducing the vulnerability of the society with attention paid to socioeconomic factors. It is important to take into account the mutually reinforcing adverse effects of climate change and urbanization, which is progressing rapidly in developing countries (Figure-1).[14]

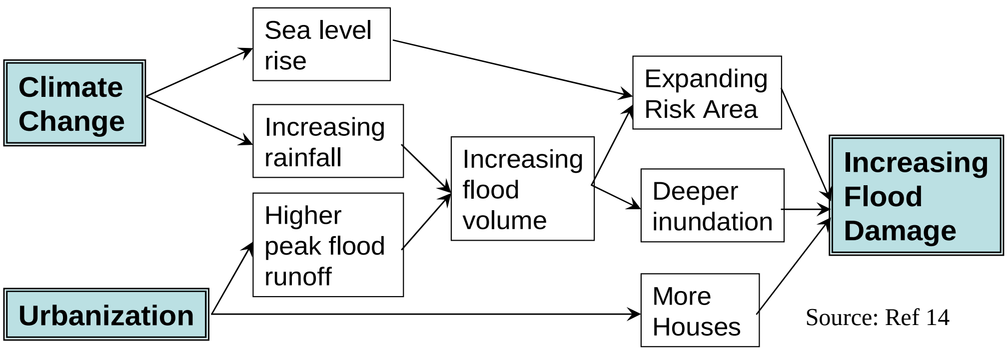


Figure 1 Increasing flood damage due to climate change and urbanization

Various actors in the whole basin should join forces to take multilayered and resilient measures, addressing not only structural aspects such as levee construction, but also non-structural aspects, including evacuation, capacity development, and regional, urban, and community development.

(e) Setting clear targets for flood control: towards "zero victims"

It is important to recognize that there is no option but to live with floods because the scale of flooding will continue to increase due to climate change. Continuing to build higher levees to cope with increasing floods is no longer a practical option.

The inevitable option of accepting the inundation of floodplains where cities and residential areas are situated means pursuing the target of protecting human lives and minimizing losses. Structural measures will be limited to functions and disaster prevention bases of strategic importance. The basic principle is to eschew the conventional mainstream approach of constructing continuous levees from the upstream mountainous area all the way down to the estuary in order to confine flood water to the river channel. In fact, continuous levees do not always provide a desirable solution given the limited budget or maintenance capacity of developing country governments. Such levees may not demonstrate their effectiveness unless they complete the construction all the way from the estuary to the upstream mountainous region. They are also not a preferred option because they are less open to modification, and the key to adaptation is flexibility.

A whole-basin strategy for flood risk management can be summarized as follows:

Step 1	
For critical areas ⇒	Protection using structures: Strategically protecting urban and densely-populated areas and critical facilities using levees and other structures
Step 2	
For other areas ⇒	No settlement: Integrating the no settlement policy into development regulations and regional development programs, and constructing flood-proof buildings only with adequate evacuation arrangements.
Step 3	
For unavoidable inundation ⇒	Community-based disaster management and crisis management: Establishing a crisis management framework where communities build their disaster management capacity and local governments and NGOs support them

2. Predicting Climate Change Impacts on Extreme Events

2-1 Methods and Uncertainties

Datasets of General Circulation Models (GCMs) used in the IPCC Fourth Assessment Report can be utilized for projecting changes in floods and water resource availability. Rainfall projections over about 20 years for 2030-2050 and 2080-2100 are available. By stochastic processing of the datasets, the design rainfall for water management is obtained.

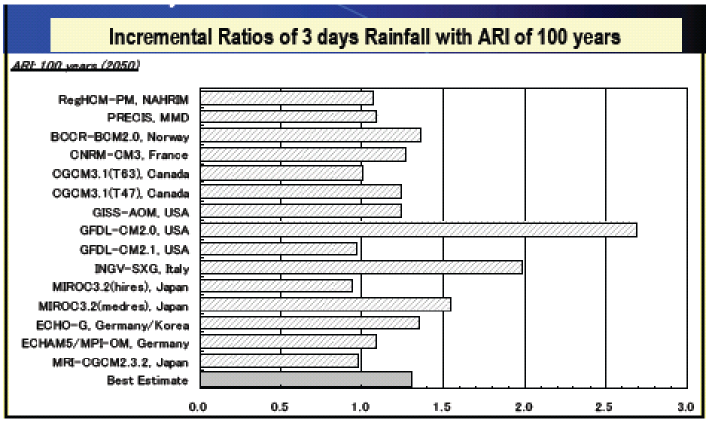


Figure 2 Different projections of rainfall in Malaysia in 100 years from now
(expressed as a ratio to the current level)

In adaptation planning, it is necessary to recognize uncertainty associated with climate change projections. There are four main sources of uncertainty: (i) limits of climatology; (ii) limits of projections using general circulation models (GCMs); (iii) the existence of more than one CO_2 emissions model; and (iv) uncertainty concerning the effectiveness of mitigation policies.[15] The third and fourth sources will not seriously affect on climate change projection until around 2050. The first source is difficult to deal with. Therefore, the following paragraphs focus mainly on the uncertainty associated with the models.

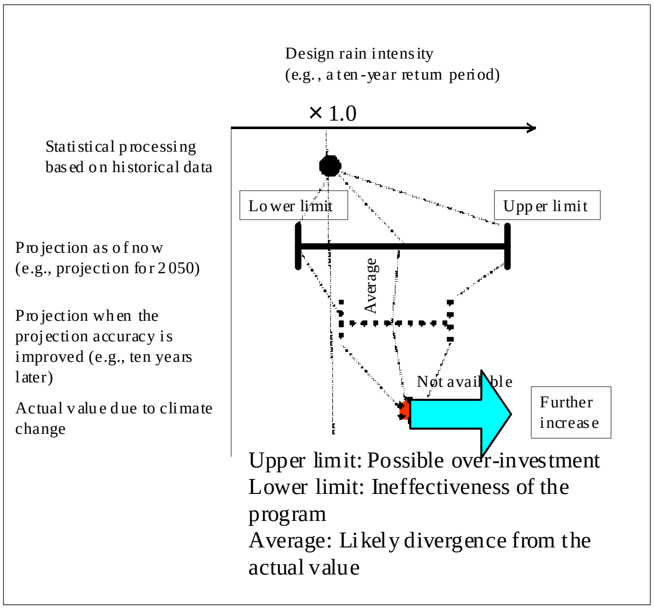


Figure 3 Concept of projection and uncertainty

It is necessary to determine which GCM fits the conditions of the project areas. For each model, outputs simulated in a 20th century run and past observed values should be compared and verified. For example, adopting a model that cannot reproduce the rainy season, Baiu, in Japan should be avoided.

Uncertainty will lessen as the projection technology develops (Figure 3). The range and mean value of the projections can be identified through comparing projections by different GCMs. In a project in Malaysia, 13 models produced different rainfall projections, with the ratio to the current level ranging from 0.9 to 2.7 (Figure 2).

2-2 Projection Model Concerning Hydrological Information

JICA has applied or is applying the following projection methods. Method (a) should be used as a basic approach. Method (d) must be applied to determine the range of uncertainty, or different projections of various models.

(a) AGCM20 downscaling (applied in Sri Lanka)

This method translates the datasets of the super-high-resolution (20-km mesh) atmospheric General Circulation Model (AGCM), developed by the Japanese Meteorological Research Institute and Japan Meteorological Agency, into data for a finer mesh. With its applicability to a river basin scale, this method produces outputs that are the most accurate (data for the finest mesh) to date.

(b) GCM dynamic downscaling (e.g., NAHRIM model of Malaysia)

JICA will not apply this method on its own because the agency does not have the necessary computer resources and expertise. It may use, however, the outputs of this method, if available.

(c) AGCM20 bias-correction (applied in Viet Nam)

ICHARM is developing the bias-correction method for rainfall projections calculated by AGCM20, which will provide a simple and practical option for developing countries, if it is put to practical use.

(d) GCM ensemble (applied in Malaysia and Sri Lanka)

Necessary outputs will be obtained after stochastic processing alone from the global data that have been already calculated by GCMs with coarse meshes (100 km or more). This method lends itself to assessment of the range and average of different outputs of various models.

(e) Simple statistical downscaling (applied in the Philippines)

This method will no longer be applied because it fails to highlight the characteristics of each basin. When applied in the Philippines, this method produced outputs that projected common growth rates for rainfall across the country.

2-3 Coasts

As for the rise in the sea level, information in the IPCC Fourth Assessment Report will be applied

3. Analysis of Damage Potential and Impact Assessment

3-1 Projecting Changes in Rivers and Groundwater

3-1-1 Flood projection

(a) **Target year(s)**: The target year will be set to a year during the 2040-50 period, although planners have considered a longer term plan, for example, a century-plan. One reason is that over this time span, variations in CO2 emissions scenarios and mitigation policies will not seriously affect projections. Another is the availability of the outputs of general circulation models (GCMs). Longer-term projections are difficult because they will vary widely depending on the choice of mitigation measures.

(b) **Target return period**: Current practice of determining the target return period will be applied to start examination of adaptation measures. For example, the Philippine government usually applies a 25-year return period for their flood control projects.[16]

(c) **Design rainfall**: Even for the same target return period, more than one design rainfall level should be used to allow for flexibility to cope with uncertainties. Such design rainfall levels may include, for example, (i) the current value without taking climate change into consideration; (ii) the value calculated using the downscaling models (model (a) or (b) in Section 2-2) or the average value from the ensemble model (model (d) in Section 2-2).

(d) **Runoff analysis**: existing methods are applied.

3-1-2 Projection concerning normal water levels, groundwater, droughts, and water environments

(a) **Target year(s)**: the same approach as the one for flood forecasting

(b) **Runoff analysis**: A tank model or a distributed model should be used for the runoff model. However, changes in evapotranspiration due to climate change will affect soil moisture and even result in changes in runoff ratios. (For example, an increase in evapotranspiration will reduce soil moisture, which will in turn result in a decrease in runoff.) Runoff analysis should consider solar radiation, temperature, wind and other factors that have traditionally been disregarded, by making heat balance calculations that incorporate climate model outputs. The model to be applied will be examined further in light of the budgetary and technological limitations.

(c) **Groundwater flow model and environmental model**: existing models will be used.

3-1-3 Coastal protection

The sea-level rise, ocean-temperature rise, and increasing frequency of massive typhoons have adverse implications, including storm surge floods, coastal erosion due to high waves, and the deterioration of coastal environments. The rise in sea levels will occur over decades to centuries, while extreme weather conditions last for days to weeks. This difference in time scale should be taken into account. Efforts have been made to assess climate change impacts with prediction models that combine AGCM20 with a wave prediction model.[17,18] These models, however, have not been sufficiently developed to be put to practical use. The near-term target will be to improve assessment accuracy by analyzing trends in changes based on observational data on tidal levels and wave conditions and keeping track of the development of relevant technologies.

3-2 Existing Facilities, Plans, and Management Structure: Identifying Existing Coping Mechanisms

It is important to identify and inventory existing facilities, plans and institutional frameworks for disaster or water management that may be used for adaptation.

(a) Structural measures: existing facilities such as levees, dams, reservoirs, irrigation facilities, water supply facilities, and channels

(b) Institutional framework: governmental organizations (agencies of meteorology, rivers, irrigation, water supply and disaster management, drought conciliation councils, etc.), forecasts, warnings and communication systems, local governments, universities, NGOs, research institutes, etc.

(c) Areas that may not have been identified but need to be identified for implementing community-based measures. Examples are as follows:

- ✓ Evacuation arrangements: information sources, timing, means of communication, evacuation routes, evacuation shelters, living conditions at the shelters
- ✓ Community facilities: irrigation ponds, rainwater storage facilities, riparian forests, erosion protection works
- ✓ Existing organizations such as community organizations, co-operatives, water users associations

(d) City plans and regional development plans: Any basin-wide measures should be consistent with these existing plans.

<u>Case study: JICA (2009) "Assessment Report on the Response to Typhoon Ketsana in the Central Region"</u>[19]

Typhoon Ketsana of September 2009 cause havoc in central Viet Nam. One month later, JICA studied how communities and the central and local governments had responded to this disaster. The main findings are as follows:

- River water levels were higher but the death toll was one-third compared with the 1999 flood.
- Learning lessons from past experience, communes (communities) played a central role in flood preparedness. However, the level of preparedness varied depending on the commune, and some areas were unprepared for the floods.
- The elderly, the disabled and other most vulnerable groups were safely evacuated prior to the disaster with the help of volunteer groups and the staff of the authorities concerned.
- Prolonged electric power failures rendered the usual communication systems inoperative, making it difficult for the authorities concerned to communicate with one another.
- Riparian forests proved to be effective in mitigating flooding.

A boat and raft for evacuation

3-3 Damage Potential and Impact Assessment

3-3-1 Flood disasters

(a) Inundation analysis:

Since flood inundation is managed in floodplains, it is essential to simulate and analyze the inundation. If the elevation data for the floodplains, which is necessary for simulated calculations, is not available, either of the following options will be applied:

A) Using 30-m mesh satellite images with corrections, or

B) Conducting interview surveys on the largest flood and yearly floods to date to estimate the inundation depths

Natural disasters can be classified according to the stage of socioeconomic development as shown below:

(i) **Rural disaster**: A disaster whose scale of damage is determined solely by the scale of hazard in the absence of significant social capacity for disaster management.

(ii) **Urbanizing disaster**: A disaster in newly-developed areas, notably those around cities as a result of urban sprawl

(iii) **Urbanized disaster**: A disaster whose damage is centered on “life line” public utilities in cities

(iv) **Urban disaster**: A disaster that causes devastating personal and property losses in complex-structured, densely populated districts.

(Source: JICA. *Bosai to Kaihatsu ni Kansuru Kiso Kenkyu Hokokusho [basic research report on disaster management and development]*, 1998, with adjustments

(b) Impact assessment:

Damage and vulnerability will be analyzed through an inundation analysis.

A) Areas that have so far been examined in JICA projects will be examined:

- ✓ Data on physical phenomena, including the frequency, areas and depths of the inundation
- ✓ The affected population, the number of damaged buildings, agricultural losses
- ✓ Impacts on physical infrastructure and economic activity in terms of road disruption, factory closedowns, business suspensions and other indicators

B) Areas that may not have been examined but need to be examined to implement measures from the perspective of human security:

- ✓ Damage to specific vulnerable groups, including the poor
- ✓ Damage to the livelihoods and property of individuals

3-3-2 Droughts

Droughts will likely increase over low latitudes and mid-latitude continental interiors in summer. It is also predicted that by the 2090s, the proportion of the land surface in extreme drought, globally, will increase 10 to 30 times, and that the number of extreme drought events of a 100-year return period and the mean drought duration will increase two times and six times, respectively, during the same period.[1] In Africa, vulnerability to droughts will likely deteriorate further.

Africa's vulnerability to droughts[1]

The agricultural sector is critical for local livelihoods and national GDP in Africa. It is also sensitive to climate variability, notably periods of prolonged droughts. Many African countries already face semi-arid conditions and depend on inefficient irrigation systems. One-third of the people in Africa live in drought-prone areas. Climate change is likely to force large regions of marginal agriculture out of production.

Changes in the seasonality and intensity of rainfall could result in deficiencies in yields from rain-fed agriculture of up to 50% during the 2000-2020 period and in reductions in the crop growth period. Even in the absence of climate change, present population trends and patterns of water use suggest that many African countries will exceed the limits of their economically usable freshwater resources by 2025. Water scarcity can trigger additional conflicts.

3-3-3 Coastal protection

The impacts on coastal disasters are identified as follows.[20,21] USAID has detailed the damage potential and impact assessment in coastal areas.[22]

A) Inundation risk (normal, temporary)
B) Coastal erosion and the stability of structures
C) Groundwater level rise
D) Salt intrusion into the ground and river water
E) Impacts of rises in water temperature and erosion on coastal ecosystems (vegetation change, coral bleaching, etc.)

People's lives are at risk of being significantly undermined not only by substantial shoreline retreats due to a sea-level rise, but also by local scouring, as well as a significant decrease in the extent of beaches due to increases in the amount of sediment transport resulting from the intensification of high waves and storm surges. A larger proportion of the population gains their livelihood from the sea in developing countries that have islands or shorelines than in their land-locked counterparts. In many areas of such countries, settlements are situated along the shore where the only community road also runs,. Coastal erosion is thus literally a matter of survival for local residents in such situations.

Along much of the shoreline of developing countries, mangrove forests, coral reefs, and beaches protect human settlements by mitigating high waves and storm surges. In other words, settlements are often situated along such shores. These ecosystems, which may change significantly due to climate change, should be taken into account in adaptation planning.

<u>Case Study: Three Major Bays of Japan (Ministry of Land, Infrastructure, Transport and Tourism; storm surges)</u>[23]

Focusing on the three major bays (Tokyo, Ise, and Osaka bays), this project developed a model for describing inundation in the inner part to project inundation caused by storm surges using data on sea-level rises and typhoon intensities. With the Ise Bay Typhoon on the same course of 1959 serving as the standard typhoon, damages to areas along the three bays are estimated. In a business-as-usual scenario with a sea-level rise of 0.24 m and a typhoon intensity 1.3 times the 1990 level for 2100, the associated storm surge would inundate a total area of 72 km^2, affecting some 350,000 people and 2.3 trillion yen in losses late this century (2081-2100).

3-3-4 Glacial lake outburst floods

(a) Analysis: In mountainous regions such as the Himalayas and the Andes, glaciers have melted and retreated, and the melt water has been dammed by end moraines to form lakes. The lower river basins may be hit by a flood from moraine collapse when landslides, slope failures, avalanches, or hanging glacier failures cause huge waves on the lake surface or when the ice melts or piping occurs within the moraine.[24] The detailed mechanisms of these failures are unknown. Priority should be given to identifying dangerous glacier lakes through continuous surveys and analyses and to developing methods and improving their accuracy, with the focus on:

A) Analyses of glacier lake dynamics and collapse risks using satellite data
B) Analyses of the structure, thermal environment, and collapse mechanisms of glacier lakes based on field surveys
C) Development of a monitoring system using remote sensing and other technologies

(b) Management and impact assessment: The scale of damage due to these types of disasters, which occur in high-altitude remote areas, is not substantial compared with other types of natural disasters that have occurred in recent years. Through inundation simulations or hypotheses on moraine collapse mechanisms, the damage can be estimated. The execution of drainage or other works and the identification of monitoring items in an early warning and evaluation system may face many technical challenges due to the high altitude.[24]

4. Adaptation Planning

4-1 River Basin Governance

(a) Framework

Adaptation planning involves a wide range of stakeholders, including central and local governments, NGOs, communities, as well as various sectors. It also hinges on voluntary activities on the part of communities. It is therefore important to establish a council or forum made up of stakeholder organizations, experts and academics at the early stages of planning. Such a council may be tasked with making decisions, offering advice, or provide information depending on the characteristics of the country or region.

> The World Bank's WDR 2010 gives priority to:[3]
> (i) No regrets option
> (ii) Buying "safe margins"
> (iii) Reversible and flexible options (urban planning, insurance)
> (iv) Long-term planning

(b) Key functions of a council

A) Building a consensus on planning and program components among the stakeholders
B) Reflecting local knowledge in adaptation planning
C) Communicating with experts, implementation agencies and residents regarding their expertise on climate change and variability.
D) Clarifying the responsibility of each agency
E) Encouraging voluntary activities

(c) Assessment of the psychology of the residents

A permanent system that will contribute to resolving a range of water-related issues in the river basin should cover single-purpose, time-limited activities such as a specific flood control project or master planning. It is stresses that "decisions" in the evaluation structure affect factors determining psychological processes.[25] It is necessary to integrate the changing process of the residents' evaluation of rivers in this mechanism using:

A) An evaluation structure model to identify factors that determine the residents' appreciation of rivers. Four processes are involved: (i) the external environment; (ii) decision making; (iii) evaluation; (iv) overall evaluation.

B) A psychological process model to identify factors that prompt residents to have an interest in and interact with rivers. Five processes are involved: (i) knowledge; (ii) interest; (iii) motivation; (iv) intention to act; and (v) action.

Case Study: JICA's Study on Integrated Flood Management for the Nyando River Basin in the Republic of Kenya in 2009[26]

A Nyando River Basin Water Management Forum was established for information sharing and consensus building. With the participation of a range of stakeholders in the entire basin, including government organizations, NGOs, private sectors, and community organizations, this forum approved a master plan, selected community projects and monitored their implementation. The forum remained active as a voluntary organization even after the study.

Flooding (Dec.2006)

Source: Study on Integrated Flood Management for the Nyando Rover Basin, Final Report

4-2 Meteorological and Hydrological Observation, Warning, and Evacuation

(a) Framework

Improving and maintaining meteorological and hydrological observations are considered as cross-cutting adaptation measures in the water sector. These efforts contribute to the greater accuracy of climate change impact assessment, a deeper understanding of extreme floods and droughts as a result of climate change, and the development of warning and evaluation systems. Improved capacity to forecast local atmospheric phenomena will contribute to adaptation planning by lessening uncertainties associated with such planning

(b) Important considerations

Providing sufficient support to capacity development in operational and maintenance is necessary for developing systems of radar, telecommunication, and high technology for data processing. It is also important that JICA empower other agencies and communities to provide information useful for evacuation and other disaster-prevention activities, as well as help to strengthen evacuation systems.

4-3 Flood Disasters

(a) Target setting

Key steps, like the ones shown below, should be studied based on the existing coping mechanisms, inundation types, damage potential, and impact assessment analysis, and in line with Section 1-2, (e) Setting clear targets for flood control: towards "zero victims."

Step 1: Protection of strategic facilities

- ✓ Cities, regions and facilities that should be strategically protected with structures

Step 2: No settlement

- ✓ Areas where development should be controlled due to the high risk of a disaster
- ✓ Areas that should be conserved to minimize damage such as upstream forests
- ✓ Areas that conserve the inundation retarding function

Step 3: Community-based disaster management and crisis management

- ✓ Community-based disaster management
- ✓ Roads utilized as evacuation routes during a disaster
- ✓ Evacuation shelters that need improvement

(b) Facilities planning

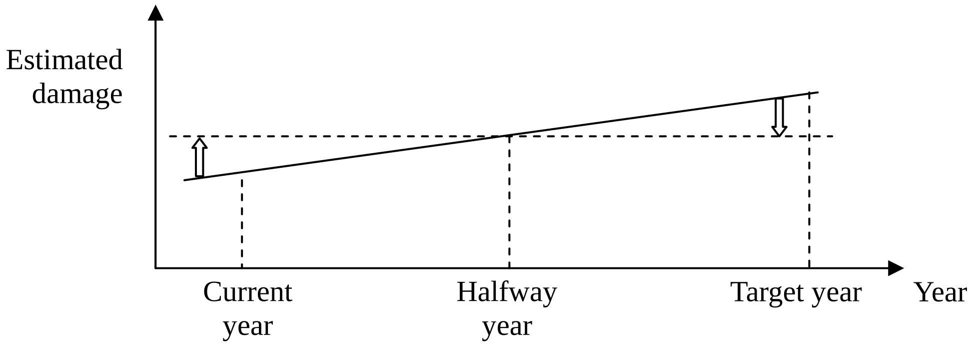
The prospects for the ever-increasing magnitude of disasters highlight the need for flexible and resilient responses. The following measures should be considered. One viable option may be to construct structures that allow for staged construction in preparation for possible extensions in the future. It is not desirable to adopt easy solutions, for example, parapet concrete walls for which renovation is difficult. A quantitative estimate should be made of the effectiveness of these measures where inundation analysis has already been completed.

- ✓ Protection of strategic areas and facilities: link levees and erosion works to protect cities and critical facilities
- ✓ Retarding basins and conservation areas: conserve the inundation retarding function of paddy fields and wetlands
- ✓ Raising of housing land
- ✓ Raising of road levels: for use as a secondary levee or an evacuation route
- ✓ Coordinated development with urban facilities (parks, public buildings, etc.)

(c) Economic assessment[23]:

Economic assessment should be conducted with reference to the manual developed by the River Bureau of the Ministry of Land, Infrastructure, Transport and Tourism in April 2005 entitled "Chisui Keizai Chosa Manyuaru [Economic survey manual on flood control]." The frequency of flooding should be estimated taking into account the impacts of climate change. Usually, the benefits of intervention are assumed to be equal every year, but these benefits will mostly likely be affected by the impact of climate change. The annual benefits should be estimated to reflect these impacts. Yet assessing climate change impacts for each year may be too complicated a process to be practical. An alternative viable option may be to use the projected benefits at a year halfway between the current year and the target year as the benefits for each year on the assumption that the benefits will change at a fixed rate until the target year.

There are no established methods for quantitatively assessing the improvement of disaster management capacity through non-structural measures such as building the capacity of communities to evacuate. Such assessments have to be made on a case-by-case basis.



(d) Regional/Urban Planning, Land Use Control

While most developing countries are suffering from continuous urbanization, climate change also accelerates an increase of the disaster risk. Appropriate measures for planning and control from the initial stage of development are proved efficient and effective in comparison with the measures to catch up. Urban planning and regional development in Japan have been closely linked to disaster management. However, Japan has experienced belated planning and safety control because of a rapid increase of population and urbanization. The following considerations are essential to assist measures for climate change adaptation in developing countries.

A) Risk zoning and development control

✓ Limit the use (prohibit to live) in a grave damage risk zone, or live after taking measures (using flood-proof structure such as reinforced concrete or high level of living floor)

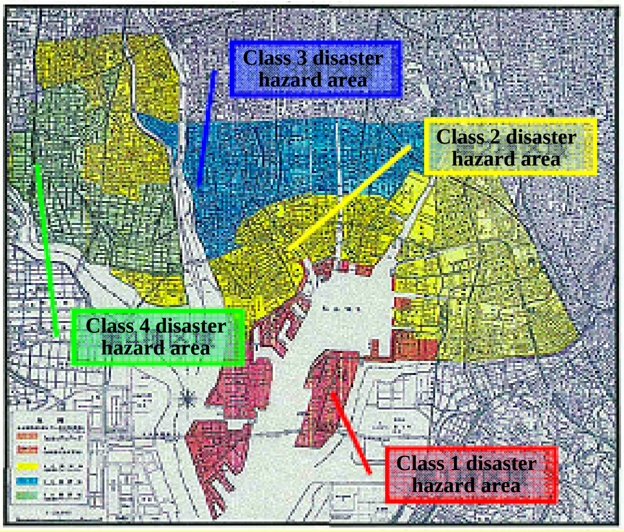
Zones where grave damages by floods, tidal waves and tsunamis are predicted should be used as agricultural field, playground or non-residential facilities and such zones should be prohibited to construct houses. (e.g. as the former byelaw on coastal zone management in Nagoya city)

However, it is almost impossible and impractical to prohibit from constructing houses when urbanization has been progressed. And houses can be permitted to construct under the condition such as utilizing reinforced concrete frame that can resists flood and tsunami, raising level of housing lot and level of floor to live, and establishing obligatory evacuation spaces. (e.g. Current byelaw on disaster management of buildings in coastal zones, Nagoya)

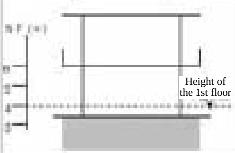
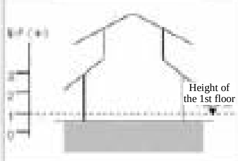
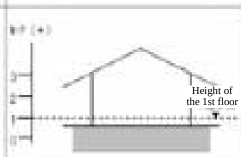
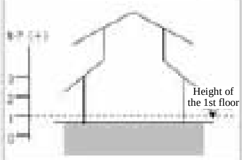
Especially in the case of landslide risks, consensus of residents can be formed easily to designate disaster risk zone and to forbid housing construction. In the latter case of permission to live with conditions, software measures like evacuation drills, disaster education and early warning systems are needed to be prepared at the same time.

Case Study: Nagoya City's Building Ordinance for Coastal Areas

Hazard map of the coastal areas in Nagoya city



Building standards law (the provisions concerning disaster hazard areas)
Article 39 Local governments may, in an ordinance, designate areas prone to tsunamis, storm surges, and floods as disaster hazard areas.

	Height of the 1st floor above the NP	Structural regulations	Diagram
Class 1 disaster hazard area	4 m or more above the NP	No wooden buildings are allowed	
Class 2 disaster hazard area	1 m or more above the NP	Habitable rooms should be on the second floor or above. However, this regulation is not applicable if one of the following three requirements is met: (i) The floor height of one or more habitable rooms is 3.5 m or more above the N.P. (ii) The same premises include a two-story or higher building. (iii) The building has an evacuation chamber or facility if its total floor area is less than 100 sq.m.	
Class 3 disaster hazard area	1 m or more above the NP	———	
Class 4 disaster hazard area	1 m or more above the NP	Habitable rooms should be on the second floor or above. However, this regulation is not applicable if one of the following two requirements is met: (i) The floor height of one or more habitable rooms is more than 3.5 m above the NP (ii) The same premises include a two-story or higher building.	

Class 1DHA
Areas on the seaward side of seawalls; mostly waterfront industrial areas on reclaimed land

Class 2DHA
Both coastal areas that had already been built up before the Ise Bay Typhoon and those that were built up after the typhoon as part of the land readjustment and other programs; these two types of areas are characterized by similar land use.

Class 3DHA
Inland areas that had already been built up before the Ise Bay Typhoon and require less stringent regulations than other types of areas because they are situated farther from the sea.

Class 4DHA
Urbanization control areas designated under the city-planning program

Source: The description and explanation of Nagoya's building ordinance for coastal areas on its website.
Note: NP stands for the Nagoya Peil, which is an estimated constant for the sea level of Nagoya Bay, as in the Normaal Amsterdams Peil or Amsterdam Ordnance Datum.

Case Study: Development control
Development controls have been carried out by the national government of India since 1991 (amended in 2007) and immediately after the Indian Ocean Tsunami in Sri Lanka both include a development control within the areas less than 500m from sea coast lines. In the cases of transferring communities, financial supports should be prepared to decrease economic burden. (e.g. Promotion project for community relocation in disaster risk zones and financial support for houses in high risk areas of landslides in Japan)

Use of topographical data (DEM) for city planning and land use regulation

Digital maps (DEMs) provide basic information for flood inundation simulations and GISs. Today, satellite image-based, high-resolution DEMs are readily available for almost all areas around the globe. ASTER GDEM, whose distribution began in June 2009, is attracting attention as a readily-available, easy-to-use DEM. It covers almost all areas in the world with a resolution of 30 m. As far as urban and other limited areas are concerned, DEMs based on ALOS images with a resolution of 10 m are useful. A more detailed DEM may be made based on altitude data from a paper-based, large-scale map (notably a scale of 1 to 2,500) where available. DEMs based on satellite images should be handled with care in analyzing flatland because they might not always provide well-corrected data.

✓ Development control in the regions where will cause flood with grave damage
When forests that have water retaining function located in upper stream or agricultural fields that can serve as a reservoir in a case of flood are developed, flood damages are aggravated. It is necessary to control new development projects in such reservation areas by regional and urban development planning from the view point of disaster management. Proper urbanization of safer areas can be introduced by not investing in the risk areas.
Japan introduced "Area division" and "Development permission" to promote investment in urbanization promotion area within approx. 10 years, and also established permission conditions for a new development to prepare disaster management facilities, during the era of rapid urbanization (1960-70s).

B) Obligatory development of rain-water penetration facilities and flood control ponds
New development should prepare obligatory measures to mitigate negative impact of the development
To prepare heavy rain falls in a short period of time, rain-water penetration facilities and flood retarding basins can be introduced as obligatory measure for a new development. Those facilities are normally funded by governments if they are located in urbanized areas while it is rational to be funded by the developer in a new development. Open and objective technical standards will ensure the transparency and impartiality of the governance.

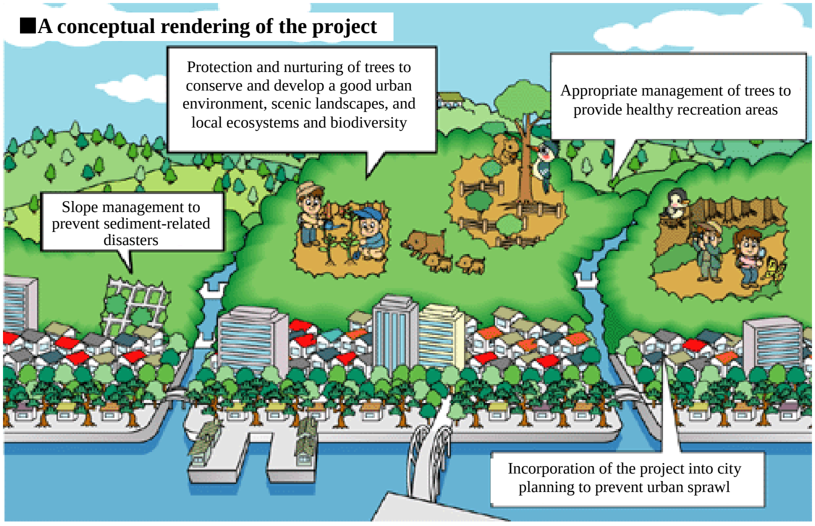
C) Green Belt (Surrounding open/green spaces)
It is desirable from disaster management, urban environment and landscape view points to designate preserved green areas at an early stage of urbanization if a city is surrounded by forests or located closed to hills. In particular forests play a major role to prevent floods and to reserve water resources.
When a public organization owns the green area, maintenance can be carried out as

far as the budget is sustainable. In the case of green areas owned by private companies or individuals, the land can be designated as a controlled area within the total city planning. At the same time, it is desirable to establish measures to alleviate financial burden by tax exemption, subsidy for maintenance or authorization of rights to request the government to purchase the land. In the cases to preserve agricultural field as a green zone, urban planning and agricultural land planning must be coordinated to secure future agricultural use.

Case Study: Rokko Mountain Range Green Belt Development Project

The Hyogo-ken Nanbu Earthquake in January 1995 resulted in slope failures and fissures in many parts of the Rokko Mountain Range.

The hillsides became unstable due to the quake and could cause a disaster because of heavy rain in the future. This concern prompted governments to launch this project to conserve and even develop the greenbelt in the mountain range in order to increase local resilience to sediment-related disasters and create green landscapes and a leafy urban environment. The Hyogo Prefectural Government and four municipal governments within the prefecture (Kobe, Nishinomiya, Takarazuka, and Ashiya), announced in July 1998 the designation of hillsides facing built-up areas as areas serving as sediment control facilities and landscape conservation areas, both of which required active interventions in the project area.



Source: Ministry of Land, Infrastructure, Transport and Turism Kinki Division Rokko Sabo Office website

D) Establishment of a legal framework and its proper implementation

In many cases, legal frameworks and control systems have been established after devastated disasters. Though most of people understand reason of the established regulation immediately after the disaster, regulations and systems that are contradictory to daily benefit, tend to be disregarded with the passage of time. Especially in the case of tsunami disaster, it often occurs since no one knows when the next tsunami comes.

Therefore, in establishing a new law, a proper level of restriction that can be easily followed in daily lives and supplementary measures need to be prepared at the same time in order the law to be effectively implemented. (The following “E)” is very important.)
A control system can be conducted with economic measures and through provision of easily understandable information to the residents. Particularly, it is critical that the reason of a certain control system should be explained to the extent that all levels of people can understand.
In the cases of a permission system, unclear permission criteria often cause problems of governance. Control systems based on scientific basement such as climate change adaptation need clear objective permission criteria to the public so as to provide same permissions to everybody under the same conditions.

E) Organizations, Process and Capacity Development

Above-mentioned practices are carried out by local governments that are not so capable in general. Establishment of an organization, allocation and training of staff are principle measures.

Under the centralized governmental conditions, central government normally notifies new frameworks and criteria to local governments. Implementation of a system which local governments and residents cannot comprehend its contents and background often faces difficulties even in the case of disaster management to save lives. Although the decentralization has progressed, established byelaw cannot be properly carried out if there is no staff post or only a staff holding other posts concurrently. Then, in any cases, when national and local governments formulate a position for disaster management, capacity building of the staff will be the key to implement the system.

In the cases of local governments, measures to think about climate change adaptation with residents, namely community based disaster management (CBDM) will serve a good opportunity both to train officers and to raise awareness of community people. Concrete activities for CBDM includes town-watching, evacuation drills, preparation of leaflets, going round and caring vulnerable people in a community and distribution of foods so that many people can join and manage by themselves.

(e) Community-based disaster management and crisis management

The disaster management capacity of communities has recently come to be of increasing importance. The reasons for this are that "climate change impacts are manifested locally", "vulnerability and adaptive capacity are also realised locally" and "adaptation action is best observed at local levels" [27]. Special emphasis should be placed on prevention in series in a disaster management cycle; prevention, response, and recovery. Because disaster management is a part of community activities, any intervention should take community governance into account, with the focus on, for example, "building trust between partners in a joint venture".[28]

Since the impact of climate change and variability will be different from community to community, any solution should include a number of options to better cope with specific conditions[29]. The environment and disasters are linked to the overall concept of human security[30], and climate change will magnify the uneven social and territorial distribution of risk, with an increase in the risks faced by the poor, thus further amplifying poverty.[31] Hence, all highlight their concern that the poor might see their situation deteriorate further. Reducing such downside risks requires paying greater attention to the poor and other vulnerable groups.

Communities have limitations as to their response to disasters. Assistance from the government sector is crucial, and JICA should take this perspective fully into account.

A) Assessing the strengths and weaknesses of a community (risk and capacity assessment):

The main purposes include predicting what kind of geography-related disaster risks the targeted community might face as a result of climate change from the civil engineering point of view, and identifying the physical strengths and capacity of the community (in terms of topography, site conditions, facilities, and other factors). At the same time, the social aspects should be addressed. More specifically, it is necessary to identify social strengths and weaknesses and understand how the community works in order to design interventions that will suit the needs of the community.

The social factors that need to be identified may include how aware the community members are of the need for disaster management, what disasters they have already experienced, and how they responded to them, as well as the state of community governance (in terms of decision-making and communication), community resources (financial, environmental, and technical resources, social capital, and community organizations), and government-community cooperation arrangements.

Due to its impacts on agriculture and health as well as the water sector, climate change may disrupt the working of the community itself, which is clearly the key actor in community-based disaster management. For reference, the risks that have been largely disregarded, but which the community might face in the future, are summarized as follows:

- ✓ **Agriculture**
  - – Loss of livelihood (Adherence to farming and fishing practices based on traditional calendars might increase the risk of the loss of livelihoods. In such cases, assistance will be required to help farmers and fishers to gain access to alternative crops or livelihoods.)
  - – Deterioration of poor households (Poor households will likely be the hardest hit by a disaster. In such cases, assistance will be required to help them gain access to materials and resources that will reduce the vulnerability of agricultural crops to droughts, including improved varieties and irrigation technologies.)
- ✓ **Health**
  - – Increase in infectious diseases (The rising temperature will likely result in more malaria and dengue fever infections.)
  - – Nutritional deterioration (Some cases have been reported in which droughts and the resultant hunger delayed the growth of children.)

B) Project planning

The next step is to design and plan a project that addresses both structural and non-structural aspects based on the findings of the community assessment and in the light of other programs such as the existing national development program and community disaster management program. Disaster management involves a wide range of sectors. Medium- to long-term planning might mean that JICA will have no choice but to expand its scope to include sectors in which it has little experience. JICA should carefully study how far the project should go in this regard.

- ✓ **Infrastructure development**: evacuation shelters,, evacuation routes, water and sanitation facilities, flood control facilities, rainwater drainage facilities (especially in urban areas), household storage facilities using small-scale construction methods, etc.
- ✓ **Environmental conservation**: management of natural resources within the community (appropriate forest management)
- ✓ **Establishment of a forecast/warning system**: affordable rain gauges; a warning system that takes advantage of a range of communication means, including traditional means, radio, TV, and ICT; and a communication network designed to

keep everyone in touch during a disaster.

- ✓ **Human resources development**: training and workshops (disaster imagination games (DIG), study meetings, etc.)

  NB: The purpose is to raise disaster awareness by learning about disaster-causing mechanisms, possible future risks, community knowledge, and the roles to be played by governments, communities, and individuals, and through simulated risk experience. These sessions can be held during opportunities such as school education and community meetings.
- ✓ **Development of voluntary organizations for disaster preparedness**: the establishment and operation of such organizations by taking advantage of existing organizations within the community. (Their activities will cover the normal, response, and recovery phases.)

  NB: Some cases have been reported in which a voluntary organization for disaster prevention was established but failed to take root in the community with their activities becoming more of a formality. Project planners need to fully assess the community situation.[27-02]
- ✓ **Dwellings**: work to make existing buildings more disaster-resistant, resettlement, upgrading of squatter settlements
- ✓ **Safety nets**: micro-finance, micro-insurance
- ✓ **Budget**

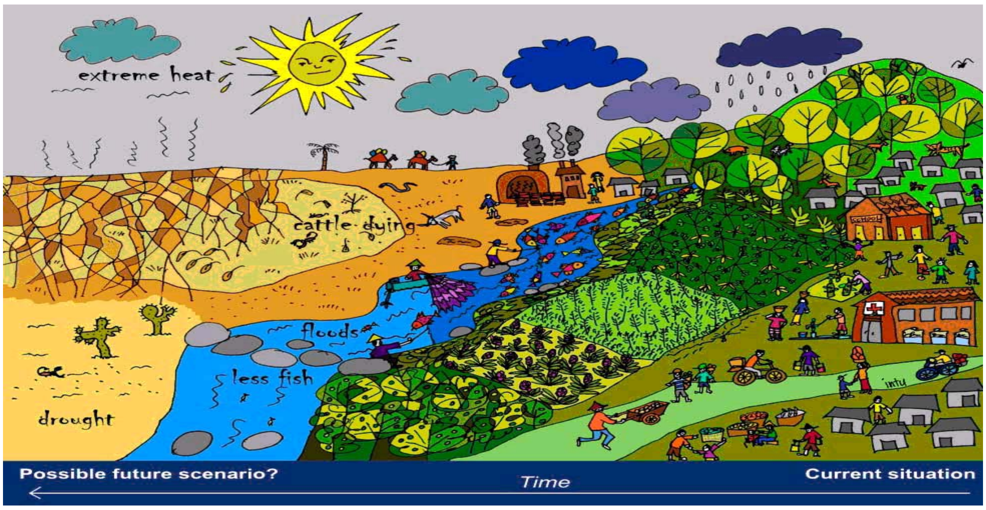
C) **Project appraisal**: A pilot project will be conducted in the community as part of the main project for the purpose of project appraisal.

D) **Project formulation**: Based on the findings of the pilot project, the main project will be formulated from the medium- to long-term perspective. Climate change impacts will manifest themselves over the medium to long term. Efforts at the community level should be maintained accordingly. An important consideration is to support the development of a mechanism whereby communities can carry out this work autonomously.

E) **Establishment of a risk communication framework through a series of efforts**: The focus should be placed on building a mechanism whereby the stakeholders, including the central and local governments, communities, and NGOs, share information for problem solving. (This information should include risk management information during normal times, disaster updates, knowledge held by the government sector and academia, and community knowledge.)

Case Study: Risk Communication in Zambia (IUCN (2008)

Finland and IUCN jointly conducted this risk communication project as part of the assessment of vulnerability to climate change. With the help of visual materials, local communities in Zambia were asked to recall the adaptation measures they had traditionally taken in the face of climate variability in the past. In addition, they were asked to conceive of adaptation strategies at the current time and predict to what extent climate change will bother them. Through communication with the communities, the international donors assessed their vulnerability. The donors learned that the communities had noticed climate variability but had little understanding of its causes, including deforestation. Based on these findings, Finland and IUCN developed an adaptation program that builds on the traditional adaptation measures of communities and takes advantage of various kinds of knowledge.



(Source: IUCN)

JICA's report on community-based disaster management from the perspective of capacity development[27-01]

(1) Project design
- (A) Conducting capacity assessment, which provides a basis for project formulation. (project preparation)
- (B) Organizing a group of various actors to implement the project
- (C) Capitalizing on local resources (utilization of community resources)
- (D) Finding leaders (utilization of community resources)
- (E) Ensuring flexibility in planning and operation (project planning)

(2) Ensuring sustainability and replicability
- (A) Developing the project framework
- (B) Establishing communication channels with government officials
- (C) Financing

"A User's Guide" on Community Based Disaster Management of UNCRD (2004)[29]

(Key issues)
1) Promote and strengthen a "culture of coping with crisis";
2) Enhance public perception of vulnerability;
3) Recognize the motivation of community initiatives;
4) Increase community participation and empowerment through institutionalization;
5) Focus on needs-based training approaches;
6) Involve diverse stakeholders based on needs and objectives in formal and/or informal ways;
7) Promote tangible / intangible accumulation of physical, technological, and economic assets as project outputs; and
8) Promote the integration of community initiatives into the usual development planning and budgeting to ensure sustainability.

("A User's Guide" aims at respective disaster managers such as policy-makers, national and local officers, trainers and community workers.)

(Background)
In order to practically apply measures for CBDM, drastic support on governmental policy, decentralization and budget are required as well as understanding and efforts by local communities. It is critical to involve counterpart organizations and governments to hold community meetings to exchange views and to develop a regal framework for strategic implementation at a national level. In addition, the User's guide is translated into local languages and widely disseminated for the use of local communities and disaster managers. It is hoped that CBDM is incorporated into respective policies towards safe and secure communities and sustainable development.

4-4 Integrated Water Resources Management (IWRM): Water use and the environment

(a) Framework

Strengthening water resources management is crucial in adopting adaptation measures to combat the projected climate change and related changes in terms of rainfall, snowfall, glaciers, sea levels, water use patterns, and water quality. Although the concept of IWRM has long been advocated and translated into action, it has to be implemented in a more timely and integrated manner as part of climate change management. In addition, the storage capacity of water resources needs to be increased by various means. These adaptation measures are at the core of ODA for climate change adaptation. The development and deployment of new technologies should be encouraged from the medium- to long-term perspective. Readjusting the industrial structure according to the availability of water resources could be a viable option. However, because of its considerable socioeconomic implications, this option needs careful consideration.

(b) Strengthening water resources management

Climate change will likely increase the frequency and duration of droughts. More extreme weather conditions are a possibility. For example, regions where an increase in rainfall is predicted might experience less precipitation during the dry season and more rainfall during the rainy season. Scientists predict that the seasonable pattern of water demand and supply will change and notably there will be a gap between the peak runoff of melt water and the peak demand for irrigation water. Since climate change impacts will increase tensions regarding the use and allocation of available water resources, strengthening water resources management is needed.

A) Planning and empowerment regarding IWRM

Conventional water resources management has been plagued by a number of problems, including top-down and fragmented decision-making processes with little coordination between different sectors, and a disproportionate emphasis on the supply side and technical aspects. Against this background, there has been increasing acceptance of IWRM since the 1980s. IWRM[b)] is a management process for achieving two objectives: (A) integrating all forms and phases of the water cycle (surface and groundwater, water quantity and quality, land use, ecosystems, etc.), all water-related sectors (flood control, water supply and sewerage, irrigation water, industrial water, water for power generation, water for environmental enhancement, etc.), and a wide range of stakeholders; and (B) water use and control practices required to secure the quantity and quality of water resources to support the achievement of a sustainable and flourishing society, notably optimal water allocation to different water users through cooperation and coordination among them.[33] The impacts of a changing climate suggest that it is increasingly necessary to reconcile conflicting interests over the use

[b)] IWRM is defined as "a process which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" by the Global Water Partnership (GWP) [see GWP's website]. The GWP was established jointly by the World Bank, UNDP, and SIDA to promote the idea of IWRM.

and allocation of water resources. This in turn demands that the concept of IWRM should serve as a basis for integrated project formulation, the empowerment of partner country agencies, policy and institutional development, and stakeholder involvement. Valuable sources of information on IWRM include the website of the Global Water Partnership (http://www.gwptoolbox.org/) and IWRM Guidelines at the River Basin Level (UNESCO, 2009) [downloadable from UNESCO's website].

B) Developing systems for water use coordination and water allocation and coordination mechanisms

The tightening situation of supply and demand for water and increasing losses from droughts underline the importance of a water rights system and policy and institutional development for water use coordination in a drought situation and conflict management (establishing rules for such coordination, sharing scarce water among water users, and making arrangements for helping those who suffer losses, including compensation and insurance instruments and cross-subsidies). Some developed countries have adopted a water rights trading system. Yet the introduction of such a system in developing countries as a short-term solution is a challenging and impractical option.[3]

Case Study: Cooperation in Developing a Water Rights System in China[33]

In China, the government historically retains ownership of water resources. In recent years, however, the Chinese government has been introducing a water rights system as part of its efforts to address two major challenges. One is the growing calls for the more rational distribution of water amid deepening water shortages in the north and against the backdrop of the introduction of market mechanisms since the 1980s. The other challenge is deteriorating water quality.

To support the Chinese government's efforts, JICA conducted a project for developing a water rights system between 2004 and 2006. JICA suggested a basic framework for developing such a system and implemented technology transfer designed to bolster China's water management systems and improve the capacity to manage water rights. The key components of this development study included (i) administrative basic and applied research regarding public administration (eight priority projects); (ii) academic research (specified projects); and (iii) a practical case study (in the Taizi River basin, Liaoning Province). As a major program for policy and institutional support, this development study involved many stakeholders from government agencies, universities and research institutes in Japan and China. In Japan, a group of policy experts and an advisory committee were organized for this study.

Maintenance flow discharge from Water utilization Dam
©CTII

C) Monitoring and data collection regarding water resources

Water use coordination essentially requires collecting, accumulating, disclosing and sharing data on the amount of water resources (rainfall, snowfall, reservoir storage, river discharges, groundwater potential, groundwater levels, water quality, etc.), and on water allocations (water intakes, water demand, and related seasonal changes, etc.)

Case Study: Assistance to the Water Resources Information Center in Syria

Situated in a semi-arid zone, Syria has been experiencing increasingly severe water shortages due to increasing water demand and droughts. The depletion of irrigation water resources has forced farmers to abandon their farmland. Falling groundwater levels have rendered wells useless. JICA made a series of development interventions in Syria. The development study entitled "Study on Water Resources Development in the Northwestern and Central Basins of the Syrian Arab Republic" (Phase I: 1996-1997[34]; and Phase II: 1998-2000[35]) led to the technical cooperation project for the "Establishment of a Water Resources Information Center" between 2002 and 2007[36], and the Project for the Development of a Hydrological and Meteorological Observation Network[37], designed to provide equipment for the Center, under the grant aid scheme.

Discharge Measurement
Source: Evaluation Report on the Japanese Technical Cooperation for the Establishment of Water Resources Information Center

These projects have supported the establishment of an observation network concerning hydrological data and the development of human resources for the collection, organization and utilization of such data.

While placing the main focus on accumulating information on water resources and reflecting it in the policymaking process through these projects, JICA is also supporting Syria to reduce water supply leakage, to promote water-saving irrigation, and to encourage the reuse of treated wastewater as part of its integrated assistance toward promoting the monitoring and efficient use of water resources.

Case Study: Assistance for Hydro-meteorological Monitoring for the Mekong River[38]

Between 2001 and 2004, JICA conducted a development study entitled "Study on Hydro-meteorological Monitoring for Water Quantity Rules in the Mekong River Basin." JICA provided various kinds of technical assistance aimed at institutional strengthening and human resources development of the MRC and in the basin countries, including (i) surveying the hydrologic flow characteristics of the Mekong River system; (ii) supporting the Mekong River Commission (MRC) in formulating a water use plan; (iii) providing hydrological stations; (iv) conducting hydro-meteorological monitoring mainly through discharge observation; (v) filling missing data on rainfall; and (vi) developing hydrological and hydraulic models.

D) Making water use more efficient with demand-side management

It is necessary to use finite water resources efficiently to minimize vulnerability to climate change impacts. Measures to reduce water demand provide an effective solution to this end. Such measures include: (i) promoting water-saving irrigation technologies (drip irrigation, etc.); (ii) converting to crops with low water requirements; (iii) increasing utilization efficiency by improving irrigation canals (lining, better maintenance, etc.); (iv) promoting the rational use of industrial water (reuse, cascade use, water-saving processes and equipment); (v) leakage prevention; (vi) reducing water use (fair water pricing, metered charging, progressive charging, water-saving equipment); (vii) raising public awareness.

Case Study: Assistance for Water Resources Management in Jordan

Situated in a semi-arid zone, Jordan is in dire need of more water resources in the face of rapid population growth due to the inflow of refugees as well as a natural increase in the population. Frequent restrictions on water supply, groundwater drawdown, and deteriorating water quality are taking their toll on the country. In its development study entitled "Study on Water Resources Management in the Hashemite Kingdom of Jordan for 2000-2001,"[39] JICA developed a master plan for water resources with the target year of 2020 and with a view to closing the water loop as a nation. The master plan addressed two aspects. One is water resources management, including (i) quantitative management (increased efficiency of water supply and distribution and reduced pumpage of groundwater), (ii) management of water quality and the environment; (iii) organizational and institutional management (water allocation and risk management). The other aspect is water resources development including both conventional water sources and non-conventional water sources (desalination of saline groundwater, seawater desalination, wastewater reclamation).

The concept of integrated water resources management was introduced to increase the efficiency of water use and water savings, water quality conservation, and the planning of water allocation among the sectors concerned, as well as addressing water resources management. Measures to combat climate change and extraordinary droughts are also taken into consideration from the viewpoint of risk management. Based on the findings of this study, JICA continues to support Jordan in controlling leakage in the water supply and sewer systems and improving the efficiency of overall water supply with a combination of technical cooperation projects and grant aid.

Training on Water Quantitative Management
Source: JICA-Net

E) Groundwater resources management

Groundwater is a valuable water resource. In addition to its general high water quality, it provides a relatively stable source of water supply even during a drought. On the other hand, it is prone to reduced recharging associated with climate change, saltwater intrusion in coastal areas, groundwater drawdown, and land subsidence. These risks call for groundwater resources management. This includes promoting groundwater recharging, controlling excessive withdrawal with a licensing or charging system, monitoring of groundwater levels and water quality, conserving groundwater quality (controlling the ground intrusion of pollutants, and promoting sewer or sanitation facilities), saltwater intrusion control (monitoring, controlling pumpage, and securing a freshwater recharge area by, for example, installing an estuary weir and constructing irrigation ponds in coastal areas).

The groundwater in island countries is often referred to as a “freshwater lens” or layer overlaying seawater and this lens is particularly vulnerable. Measures should be taken to protect this “lens,” including monitoring and use control; the introduction of alternative sources of water supply, notably the use of rainwater and the adoption of seawater desalination technologies, and water quality conservation with wastewater treatment.

Case Study: Assistance for Groundwater Management in Bangkok, Thailand

In the 1980s, Bangkok began to control the use of groundwater amid deteriorating problems of groundwater drawdown, land subsidence, and water salination associated with the excessive pumping of groundwater. The increase in groundwater exploitation continued unabated due to the growing demand for industrial and domestic water on the outskirts of the metropolitan area.

JICA conducted a "Study on the Management of Groundwater and Land Subsidence in the Bangkok Metropolitan Area and its Vicinity" between 1992 and 1995.[40] JICA suggested the establishment of a groundwater management system and supported the formulation of a basic plan for controlling land subsidence and the salination of groundwater, by for example, developing a groundwater database, digging observation wells, and made forecasts with groundwater simulation models.

Prominent foundation pile due to ground subsidence
Source: National Institute of Informatics
http://ci.nii.ac.jp/

This study project was complemented by Japan's ODA loan project designed to improve water supply using surface water[41]and JICA's technical cooperation project entitled "Project on the Industrial Water Technology Institute (Phase I [1998-2000][42] and Phase II [2000-2005][44]). These projects promoted the spread of water use rationalization technologies for industrial water, contributing to curtailing the pumpage of groundwater for industrial and domestic use. All these efforts paid off. Groundwater levels recovered from a yearly fall of 3 meters in 1990 to a yearly increase of 1.5 meters in 2003. The yearly rate of land subsidence slowed from 25 millimeters to 15 millimeters in the same period.[43]

F) Water pollution control

Decreasing discharges associated with changes in precipitation and runoff, as well as rising temperatures, cause deterioration in water quality, which affects water use. Water pollution control requires a reduction in the generation and discharge of the pollution load (by promoting sanitation and sewerage), maintaining the natural purification capacity (through vegetation and wetland conservation), and the direct purification of surface water.

G) Improving existing water use facilities

Many developing countries lack investment funds for constructing new water use facilities. Existing water use facilities are often operated or maintained inappropriately. Improved maintenance, repair, renovation, rehabilitation, and operational review may provide a viable solution as a cost-effective option for the best use of existing assets.

(c) Increasing the capacity to store water resources

It is predicted that the frequency and intensity of droughts will increase. More extraordinary droughts are likely. In anticipation of such droughts, it is necessary to promote the storage of water resources. This storage will compensate for a projected decrease in the stock of water resources in the form of snow and glaciers. This is also an effective means of flood control.[31]

- ✓ Boosting the capacity of existing water resources development facilities (dam heightening, dam dredging, coordinated operation of a set of dams)
- ✓ Groundwater recharging
- ✓ Rainwater storage and infiltration
- ✓ Increasing storage capacity with new dams and reservoirs
- ✓ Conserving soil moisture by extending water harvesting and stone mulching in agriculture

<u>Case Study: Community Rain Water Harvesting (Sri Lanka: UNCRD)</u>

Based on a gender segregated community preparedness plan against drought, model rain water harvesting tanks were constructed in schools in Sri Lanka. Community members were volunteered their daily labor for construction of the model water harvesting tanks. A community workshop was organized to learn an importance of rain water management. (Leaflet for communities in English)

Water Tank ©UNCRD

(d) Introducing new technologies

Additional options are available for countries with relatively high economic standards or areas with such standards, notably tourist sites. These include desalination technology for seawater and saline groundwater (brackish water) and advanced treatment and reuse of wastewater. They will provide a stable source of water supply that will meet the minimum demand for domestic water regardless of precipitation.

(e) Readjusting the industrial structure

A few countries embrace, as a policy option, the idea of readjusting the industrial structure according to the availability of water resources, although this entails many social and economic difficulties. Saudi Arabia, for example, is looking to abandoning the domestic production of wheat and turning to imports for the crop. This option may include industrial relocation at the local up to the global levels. It may take the form of (i) reducing irrigation farming in areas with acute water stress, (ii) reviewing the siting of water-intensive industries, or (iii) developing water use facilities and siting industries in underdeveloped regions. This option, however, needs careful consideration due to its considerable implications.

4-5 Coastal protection

(a) Framework

Adaptive options for coastal areas include protection (structural and non-structural measures), accommodation (changes in land use patterns), and retreat (resettlement, etc.).[4]

(b) Structural measures

There are no established methods for assessing climate change appropriately and designing coastal structures accordingly. At least for the near term, adaptation planning will build on existing design standards and guidelines. Some scientists believe that a sea dike will be able to adapt to the projected sea-level rise with the replacement of its structure.[45] However, further scrutiny is needed to determine the applicability of this option in developing countries, which often have limited capacity or financial resources. In addition, adaptation planners should be flexible enough to incorporate up-to-date projections and design methods. Attention should be paid to the following physical hazards, which are subject to climate change, since they reduce structural stability:

A) Increased wave hazards caused by a greater water depth or breaker height due to the sea-level rise and local scouring, as well as more powerful typhoons
B) Reduction in the effective weight of structures with increased buoyancy due to the sea-level rise
C) Increased number of waves overtopping seawalls and sea dikes due to increased wave activity, a shift in the breaking point, and increased wind velocity
D) Increased storm surge anomalies caused by an increase in the wind set-up and suction effects on the sea surface due to a cyclone or hurricane
E) Reduced wave dissipation capacity of offshore breakwaters and artificial reefs due to an increase in the number of waves overtopping or the transmission rate due to the sea-level rise

(c) Non-structural measures

Structural measures may not be a feasible option due to the huge cost of construction and maintenance involved. Any structural measures, even they are on a limited scale, should ensure that the scale of the structure is minimized and optimized based on an assessment of the importance of land use, hazard risks, and evacuation options. Non-structural measures have a vital role to play. See Section 4-3 (e) community-based disaster management and crisis management.

(d) Coastal erosion control

Coastal erosion control is the most important and most challenging issue in coastal protection in the context of climate change. Accurate projections, which then serve as the basis for erosion control measures, are difficult. The processes of coastal erosion are subject to complex factors due to various physical elements such as wave action, near-shore currents, tides, estuary currents, topographical features, and soil conditions. The socioeconomic factors including local land use, the blockage of sediment supply from upstream due to dams or weirs, and sediment extraction, all of which also have impacts on the coastal processes The process becomes further complicated when climate change is involved. It is therefore necessary to study protection, accommodation, and retreat options from a broad-based, long-term perspective. Regarding the engineering aspect, reference should be made to existing technical standards.[46, 47] In the context of developing countries, the following factors should be taken into account for more efficient measures:

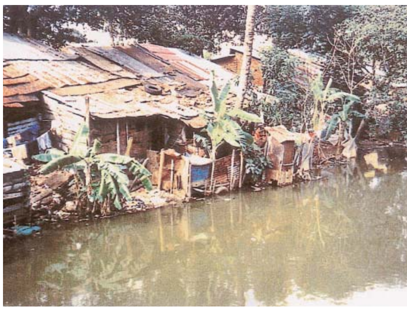
A) The optimal option for the current environmental conditions does not always match that for the future ones.
   → Structural measures are particularly dependent on whether a sea-level rise is considered or not.
B) Shoreline changes should be determined based on the results of long-term topographical surveys.
   → When "reading" shoreline changes from satellite or aerial photographs, attention should be paid to the seasonal changes of the shoreline as well as to the fact that the shoreline could move by a distance of a few meters up to several dozen meters due to the tide.
C) Will the necessary equipment be secured or procured over the long term? Will the project be sustainable?
   → Beach nourishment usually requires the continual input of materials. The long-term availability of beach replenishment materials holds the key.

4-6 Measures for the poor and the vulnerable

(a) **Measures for the poor:** It is important to study measures for the poor from the perspective of human security. For example, the planner of a flood control project must not consider the urban poor affected by the project as an obstacle to the project because of the need for resettlement. Rather the project should support the improvement of their living conditions.

Case Study: "Greater Colombo Flood Control and Environmental Improvement Project (1992-1999)"[48]

This project was designed to improve the river system (by rehabilitating rivers and building water retarding basins) in the Greater Colombo area to control the flooding that occurs annually in the area, to improve the living environment by relocating shanty residents or improving their housing areas, and thereby to improve the watershed environment. (Shanties are areas of public land, notably riverbeds and wetlands, where the poor live without land ownership.) Assistance to local communities included (i) land; (ii) communal Infrastructure (water supply, toilets, drainage facilities, garbage collection boxes, community centers, street lighting, roads etc.); (iii) housing loans and grants for low-income households; (iv) blessing money; (v) trucks for moving; (vi) construction of house foundations (for people moving outside the city); and (vii) compensation for permanent houses.


Shanties along the Canal (before Project)


Improved Canal (after Project)

Source: Evaluation highlights on ODA loan projects 2001

Case Study: River Embankment and Residential Area Improvement Project in Hiroshima[49,50]

The Motomachi district along the Kyuota River in Hiroshima, Japan, was home to so-called "Atomic bomb slums" or clusters of densely packed humble wooden houses after WWII. The development of this district began in the 1950s, and public housing, embankments, a riverbank greenbelt, and a park were constructed. This is a good example of close coordination among three undertakings: improvement of the slum district, improvement of the living environment, and flood control.

Source: Japan Society of Civil Engineers website
http://www.jsce.or.jp/committee/lsd/prize/2003/works/2003s1.html

(b) Consideration for the vulnerable: Natural disasters often hit specific vulnerable groups the hardest. The elderly in the Hanshin-Awaji Great Earthquake in Japan, women in cyclone disasters in Bangladesh, the urban poor in flood disasters in Ormoc, the Philippines, and children in the Asian Tsunami are examples. Special attention should be paid to various vulnerable groups, including the socially vulnerable, as well as economic disparities and prejudice based on ethnicity and the caste system.

Case Study: UNCRD Project on Gendered Community Based Disaster Management (Bangladesh)

Community Workshop
Source: UNCRD Highlights

The Hyogo Framework for Action (HFA) mentioned that "A gender perspective should be integrated into all disaster risk management policies, plans and decision-making processes" and also "Ensure equal access to appropriate training and educational opportunities for women and vulnerable constituencies; promote gender and cultural sensitivity training as integral components of educational and training for disaster risk reduction."

UNCRD has organized community meetings in the coastal area with the aim of discussing and developing a cyclone shelter management guideline with community shelter management committees. The following two points are highlighted in the workshop. The committee consists of 18 male and 13 female members.

1. Is there the family and social consensus to allow women (without male-members and their permission) to evacuate to a shelter?
   Community members discussed whether men can always rescue women in times of disasters. Who will help women if males' member of family were absent? Men should admit that they may not be able to rescue women even they eager to do so while women also take responsibility to save themselves and family members without relying on men. The members of the meetings concluded that it is essential to discuss these issues among family members in advance, and the society should accept capacity of women's decision-making.

2. Is an evacuation shelter safe and secure place for women?
   In order to promote women to evacuate to a shelter, the evacuation shelter itself should be a safe and secure place for women. The guideline mentioned a need for gender segregated evacuation rooms and extra care for pregnant women. The guideline will be proposed to the local government for their approval.

(c) Social impact assessment: Development projects in developing countries which require resettlement often becomes a major contentious issue, which would raise public concern. The scale of such resettlement should be kept to a minimum, considering the limited project management capacity of central and local governments. If the relocation of a large number of residents seems inevitable, the project implementation should be reconsidered.

4-7 Disaster Insurance

Insurance has its limitations as far as adaptation is concerned. Insurance should be considered as part of an integrated strategy for climate change risk management and adaptation and it should be designed to increase the incentive for conducting disaster reduction efforts, including disaster prevention activities. The following are some of the issues identified regarding disaster insurance:[3,51,52]

- ✓ It is unsuitable for long-term or irreversible climate change impacts such as a sea-level rise or desertification.
- ✓ The risk of climate change impacts is increasing, and so is the possibility that they will affect wider areas and more people. This presents a challenge for disaster insurance.
- ✓ Disaster insurance may be unable to adequately compensate individuals, communities and private funds for damage from devastating disasters such as far-reaching floods and severe droughts.
- ✓ Under more severe climate change scenarios, governments will have to take responsibility for disaster recovery as the ultimate surety. They need to secure cash and other liquid assets in anticipation of disaster damage.
- ✓ In Indonesia, a private insurance company sells index-based micro-insurance (see the third box below) under the sponsorship of the German Agency for Technical Co-operation (GTZ). This insurance pays insurance money when the water level at the designated sluice reaches the predetermined level.
- ✓ Although disaster insurance may not be able to cover public facilities or infrastructure, the idea of protecting personal assets, especially the assets of low-income people who cannot afford to pay premiums for ordinary non-life insurance, is worth further study.

Case Study: National Flood Insurance Program in the United States[52]

Established in 1968, the National Flood Insurance Program (NFIP) is under the jurisdiction of the Federal Emergency Management Agency. The NFIP designates flood-prone areas, and municipal governments in these areas can participate in this voluntary program. Citizens in these municipalities can buy flood insurance offered by the NFIP. From 1986, the program managed to maintain a self-sufficient operation. However, Hurricane Katrina in 2005 changed that. No longer able to sustain its operations from insurance revenues alone, NFIP borrowed money from the state coffers and the interest payments are now pressing hard on its operations.

Case Study: Caribbean Catastrophe Risk Insurance Facility (CCRIF)[3]

A multinational scheme, the Caribbean Catastrophe Risk Insurance Facility, spreads risk among 16 Caribbean countries, harnessing the reinsurance market to quickly provide liquidity to governments following destructive hurricanes and earthquakes.

Case Study: A New Approach in the Private Market[3]

Weather-insurance and micro-insurance products have developed and are being introduced on a trial basis. Weather-index insurance allows insurance subscribers to receive the agreed-upon amount of insurance money if the temperature, rainfall and other weather-related indexes meet certain conditions. This financial instrument is not regarded as an insurance product because it does not compensate for actual losses. In Thailand and India, however, this instrument is sold as an insurance product.

4-8 Monitoring (Evaluation and Review) and Maintenance

(a) **Monitoring (evaluation and review):** Climate change and its impacts entail significant uncertainty. Careful monitoring is therefore needed to examine whether adaptation measures have produced the expected outcomes or have resulted in unexpected adverse effects. Remedial action should be taken to improve the situation.

(b) **Maintenance:** Clearly, any facilities and equipment need proper maintenance. Because there is a risk of unexpected loss or wear-and-tear due to the uncertainty surrounding the target phenomenon, extra attention should be paid to the maintenance budget, the institutional framework, and staffing.

5. Necessary Support for Capacity Development

A changing climate will likely result in increased disaster damage, unstable water supply, and deteriorating water environment. At the same time, future projection technologies are rapidly developed. In recent years, a growing number of disaster management projects have placed communities at their core. Although climate change is a global issue, its impacts differ from region to region. Adaptation measures should be implemented at the local level by taking advantage of self-help, mutual help and public assistance resources available to local communities.

Historically, technical cooperation in the water sector was centered on assistance to government engineers. Climate change, however, calls for adaptation efforts at various levels. For the future, JICA needs to support capacity development (CD) at the individual, organizational, and societal levels in an integrated manner.

(Source: JICA (2008). Community-based Disaster Management from the perspective of Capacity Development <Kyapashithi Dhiberopumento no Kanten Karano Comyunithi Bosai>)

5-1 Approaches to Individuals, Organizations, and Societies

Climate change adaptation in the water sector requires basin-wide commitment where wide-ranging stakeholders are required to build a social consensus. This points to the importance of informing and influencing people at all levels, from central decision-makers and local government heads to the public at large, in order to raise their awareness and enhance their understanding.

The first step to this end is to assess the current capacity of each of the individuals, organizations (including communities) and societies and identify the particular areas of capacity where they are strong and where improvements are needed in delivering climate change adaptation. The next step is to decide how, and in what order, to engage with relevant domestic and foreign stakeholders (individuals and organizations), physical and environmental resources, as well as institutions and policies, and to select the optimal approaches to them.

Since new challenges arise as technological advancement and climate change bring about environmental and social changes, it is necessary to empower individuals and organizations at all levels to identify and solve their own problems, in addition to prompting technology transfer In addition, the fact that knowledge sharing and learning are two of the important factors in promoting CD[53] underlines the need for supporting institutional aspects in order to allow for human resources development at each level and the sharing of knowledge and experience within and beyond each level.

Climate change, an elusive but looming threat on a global scale, will not allow anyone to remain ignorant of his or her vulnerability, raising hopes for a more sincere commitment than ever before. In other words, it is essential to take advantage of the opportunity offered by climate change adaptation to build a consensus among all parties concerned to promote CD.

5-2 Priorities

Priorities for CD in the context of climate change include expertise in climate change projection and impact assessment, the concept of integrated flood control (basin-wide flood control), and practical technologies based on such a concept and expertise.
In addition, support for institution building that covers the regulatory framework, procedures, organization building, and human resources development with regard to city planning and land use regulations should also be given greater attention because it is predicted that the importance of countermeasures in river basins, such as the "regulation of land use" in particular, will increase.

It is important that developing countries themselves cope resiliently with new challenges that keep arising amid a changing climate. To this end, JICA should help them to promote research and development on climate change on their own. In the process, they should be encouraged to take a fresh look at the wisdom of their predecessors that has been almost entirely forgotten.

<u>Case Study: Higher Education on Climate Change Adaptation at the United Nations University</u>

Measures for climate change adaptation are extremely local in nature. They should be developed at the regional and local levels although they are underpinned by experience and expertise at the global and regional levels.

Developing a community-based adaptation strategy in developing countries requires developing locally-based useful technologies and human resources with a special emphasis on regions with a vulnerable infrastructure. Agencies implementing adaptation measures and local communities should work together to promote, at the higher education level, adaptation research that meets the needs of countries and county regions. Expertise and opinions regarding climate change adaptation have remained at the level of international forums and failed to reach people in developing countries who need them most. Against the backdrop of these circumstances, the United Nations University is now working to develop a regional network of higher education institutions.

Source: WM3 website, http://wm.hq.unu.edu/?q=node/48

6. Appendix

6-1 Climate Change Impacts

Table 2 Key Projections of Climate Change Impacts by World Region

Region	Key projections of climate change impacts
Asia	Flood • Coastal areas, especially heavily populated megadelta regions in South, East and South-East Asia, will be at the greatest risk due to increased flooding from the sea and flooding from the rivers. Water use • It is estimated that under the full range of SRES scenarios, 120 million to 1.2 billion people will experience increased water stress by the 2020s, and by the 2050s the number will range from 185 to 981 million people. • The gross per capita water availability in India will decline from 1,900 cu m/yr today to 1,000 cu m/yr by 2025. More intense rain and more frequent flash floods during the monsoon will result in a higher proportion of runoff and a reduction in the proportion reaching the groundwater. • Himalayan glaciers will recede rapidly if the Earth keeps warming at the current rate. Its total area will likely shrink from the present 500,000 to 100,000 sq km by the 2030s. Glaciers shorter than 4 km length in the Tibetan Plateau will disappear if the temperature rises by 3°C and rainfall remains unchanged. • Agricultural irrigation demand in arid and semi-arid regions of Asia is estimated to increase by at least 10% with an increase in temperature of 1°C. Coastal • For a 1 m rise in sea level, 5,000 sq km of the Red River delta and from 15,000 to 20,000 sq km of the Mekong River delta are projected to be flooded, affecting 4 million people in the former and 3.5-5 million in the latter. • A 1-m rise in sea level will lead to a loss of almost half of the mangrove area in the Mekong River delta, while approximately 100,000 ha of cultivated land and aquaculture area will become salt marsh.
Africa	Flood • Increases in runoff in East Africa and decreases in runoff and a likely increased drought risk in Southern Africa and elsewhere are projected by the 2050s. Water use and drought • An increase of 5-8% (60-90 million ha) in the area of arid and semi-arid land is projected by 2080 under a range of climate change scenarios. • The population at risk of increased water stress is projected to be between 75-250 million by 2020. • By 2020, yields from rain-fed agriculture will likely fall up to 50% in some countries. Declining agricultural yields are likely due to drought and land degradation, especially in marginal areas. Coastal • Towards the end of the 21st century, the projected sea-level rise will affect low-lying coastal areas with large populations. The cost of adaptation will exceed 5 to 10% of GDP.

Latin America	Flood • In the future, the frequency and intensity of hurricanes in the Caribbean Basin are likely to increase. Water use • By the 2020s, between 7 and 77 million people are likely to suffer from a lack of adequate water supplies, while for the second half of the century the potential water availability reduction and the increasing demand, from an increasing regional population, will increase these figures to between 60 and 150 million. • Changing rainfall patterns and disappearing small glaciers will have a huge impact on the availability of water for domestic, industrial, and agricultural purposes.
Small Islands	Flood • A reduction in average rainfall is very likely to reduce the size of the freshwater lens. A 10% reduction in average rainfall by 2050 is likely to correspond to a 20% reduction in the size of the freshwater lens on Tarawa Atoll, Kiribati. In general, a reduction in physical size resulting from land loss accompanying a sea-level rise could reduce the thickness of the freshwater lens on atolls by as much as 29%. • Many small islands in the Caribbean and Pacific are likely to experience increased water stress and be unable to meet water demand during low rainfall periods. Coastal • Sea-level rise is expected to exacerbate inundation, storm surges, erosion and other coastal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities.

Source: *IPCC Fourth Assessment Report: Climate Change 2007 - Synthesis Report - Summary for Policymakers.*

6-2 Case Studies for Reference (Climate Change Damage Projection, Community-Based Disaster Management, Flood Forecast/Warning and Evaluation)

Case Study (facilities planning): JICA Study on Comprehensive Flood Mitigation for the Cavite Lowland Area in the Republic of the Philippines in 2009[54]

Damage projection

Based on a 10-year flood, projections have been made on the probable flood inundation area and number of buildings under two scenarios: (i) a scenario in which the current climate continues; and (ii) a climate change scenario for 2050, namely the A1F1 Scenario. The extent of damage in both cases has been analyzed. Under the first, the status quo scenario, an area of 33 sq km and 22,000 buildings will be inundated if the current percentage of built-up area of 26% is unchanged. If this percentage rises to 43%, these figures will increase to 37 sq km and 34,000 buildings. Under the A1F1 Scenario, these figures will shoot up to 48 sq km and 44,000 buildings.


Inundation under light rainfall
©CTI

River flood control

1) Minimizing river channel improvement: River channel improvement designed to increase the discharge capacity will be kept to a minimum. The main focus will be placed on developing storage facilities aimed at increasing the flood water storage capacity of the entire basin, including retarding basins and flood regulating reservoirs.
   Reasons:
   - ✓ The design high water level that factors in climate change would be about 3 to 4 m higher than the hinterland ground level. Such extremely high river dikes are more likely to collapse, and once the river water level exceeds the dike crown level, the flood water will flow over into the hinterland and inundate it in a very short period of time, causing devastating damage and possibly inflicting heavy casualties. Constructing flood water storage facilities will minimize the need for elevating existing dikes.
   - ✓ Another alternative option to dike elevation would be to widen the river channel. The drawback of this option is that it would require relocating many riverside buildings. Constructing retarding basins in the upper reaches may make this option irrelevant; riverbed excavation may suffice.
2) Securing additional capacity of retarding basins: Design area requirements of retarding basins will be increased in stages to cope with a changing climate (1.9 times larger under Scenario B1 and 2.5 times larger under Scenario A1F1).
3) Securing additional capacity of flood regulating reservoirs: The design capacity of flood regulating reservoirs will be large enough to offset the increase of the peak discharge under Scenario B1.

Adaptation to deal with a sea-level rise and storm surges

1) Constructing additional sea dikes: An additional dike of 8.8 km with a design crown level of EL. 2.41 m is proposed on the west side of the Cavite Peninsula where the ground elevation of the shoreline is largely below the possible highest sea level of EL. 2.00 m in 2050 under the A1FI Scenario.

2) Revising the structural design of sea dikes: The design structure is resistant to overtopping waves at the time of an extraordinary tidal level. For the sections of the proposed dike within an inland fishpond or vacant land, an earth dike with the front concrete revetment on the offshore side is proposed. The idea is to allow the dike crown level to be elevated in stages to cope with the rising sea level. For the sections within built-up areas, a concrete dike made of massive concrete is proposed. The difficulty in additional land acquisition means that step-wise elevating is not a viable option. For the section along the river mouth, a massive concrete parapet type dike is proposed due to the extremely limited space.

Adaptation to deal with inland floods

Under a scenario of increasing short-term rainfall intensity due to climate change, inundation with a depth above the allowable level will possibly occur. To cope with this possibility, the enlargement of drainage channels and the installation of drainage pumps are proposed.

Case Study (facilities planning): JICA Development Study "Study on Integrated Flood Management for the Nyando River Basin in the Republic of Kenya" in 2009[26] and the Project for Community-Based Flood Disaster Management to Adapt to Climate Change in the Nyando River Basin" (Programme Grant Aid for Environment and Climate Change)[55]

Climate change adaptation policy (non-structural measures)

The policy is to segment the inundation area downstream using retarding basins, secondary levees, and ring levees in order to reduce the spread of flood inundation, making the communities in the basin less vulnerable to flood disasters. Putting road embankments to good use in preventing the spread of flood inundation is also part of the policy.

Structural adaptation measures

It was concluded that river bank erosion in the middle and upper reaches is the main cause of sediment discharge, a major challenge for flood management. This conclusion prompted JICA to conduct bank protection work with the active participation of local communities as part of a pilot project, which aimed to raise their awareness of bank erosion and instill a sense of crisis among them. This work, coupled with the installation of slopes designed to provide easy access to water and facilitate the supply of water to livestock, contributed to awareness-raising among local communities.


Area to be protected
Source: JICS website
http://www.jics.or.jp/

As for the lower reaches, it is necessary to improve security in the face of torrential rain and frequent floods that exceed design levels due to climate change. The following structural measures will be taken while scaling up non-structural measures:

1) **Retarding basins**
When climate change is taken into account, flood safety will dwindle to the level equivalent to a 5-year flood in the future under the master plan's scenario in which the basic flood discharge is at the level of a 10-year flood. The projected increase in the peak discharge will be addressed by elevating farm roads and using agricultural land as a major bed, rather than by building levees along the river channels.

2) **Road elevation**
In the lower reaches, increasing flooding due to climate change will likely give rise to an increase in the inundation depth rather than the flood inundation area. This will be addressed by elevating levees along the main stream of the Nyando River, as well as a second class road that runs in parallel with them. These structures will not only serve as secondary or even tertiary levees for flood control purposes, but will also be put to good use for evacuation and rescue operations during a period of inundation.

3) **Sediment discharge control**
More frequent torrential rain due to climate change will result in an increase in sediment discharges. This means a higher risk of riverbed accretion or river blockage downstream. This risk will be addressed by installing sediment catchment facilities.

Project for Community-Based Flood Disaster Management to Adapt to Climate Change in the Nyando River Basin (grant aid project)

Based on the findings of the development study, this grant aid project aims to develop a flood management framework in 24 villages that are most prone to flood hazards. In this framework, community organizations are expected to play a pivotal role. For flood control purposes, this project will implement the following structural and non-structural measures in an integrated manner. It will promote the approach of incorporating flood control measures in community development.

1) Provision of refuge bases (shelters, warehouses, latrines, wells, etc.)
2) Provision of evacuation routes (weirs, pedestrian bridges, etc.)
3) Technical assistance for a community-based flood management organization

Case Study (Facilities Planning): JICA's Preparatory Study for a Disaster Risk Management Sector Loan in the Republic of the Philippines in 2010[56]

Climate change adaptation policy

Climate change will likely reduce flood protection. Under a scenario of flood protection against a 25-year flood, which entails an emergency flood control response, the flood protection level will fall to the level comparable to a 15 to 19-year flood by 2050 and to the level comparable to a 11 to 17-year flood by 2100, while the flood discharge will rise to an increase of 11-14% by 2050 and 11-20% by 2100. Until the impacts of climate change are scientifically determined, the following steps will be taken as short-term measures:


Public Consultation Meeting
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Specific adaptation measures (structural measures)

1) **Making effective use of wetlands on the left bank of the estuary**
A sea-level rise and increasing flood discharge from upstream due to climate change will likely result in a higher water level of the Tagoloan River. To control the water level during a flood, wetlands on the left bank of the estuary will be designated as a river zone where development is restricted, in anticipation of future dredging in the estuary.
2) **Excavation of sandbanks**
In anticipation of increasing flood discharge due to climate change, sandbanks will be excavated to increase the cross section of the river, thus reducing flood hazards.

3) **Designation of inundation areas in the upper reaches**
A river zone (with a width of 250 m) will be designated upstream in anticipation of the possibility that, in the future, new levees will be constructed in developed areas to cope with a rising flood level due to climate change.

4) **Measures to cope with a sea-level rise**
The coastal low-lying areas in Tagoloan municipality are prone to storm surge floods. An area within 50 m from the shoreline will be designated as a shore protection zone where development is restricted in order to cope with a projected sea-level rise due to climate change.

Case Study (Facilities Planning): JICA Preparatory Study for Flood Risk Management and Climate Change Adaptation in South-Western Sri Lanka (underway)

With the strong influence of the tropical monsoon climate, Sri Lanka cannot afford to disregard climate change impacts in flood control planning. Structural measures for adaptation such as levee construction have their limitations. The key factor is coordination with non-structural measures such as regulating land use and developing a warning and evacuation framework, as well as with community-based disaster management. For this reason, this study examines how to assess climate change risks and reflect such an assessment in project formulation when reviewing the priority projects and conducting a feasibility study (F/S).

Project planners take a multi-tier approach to selecting flood control components, while taking into account such factors as flood hazard areas, assets, the population, and the scale of the project. They also identify three different types of areas: areas that must be protected with structures, those that can accept inundation and stress crisis management, and those where development is restricted. Moreover, project planners study a levee structure, including levee alignment, that is designed to minimize hazards in the case of a levee breach, and explore the possibility of non-structural measures, notably community-based disaster management.

The F/S will project the rainfall and conduct downscaling of the outputs of GCMs to the Study Area with input from a working group on climate change adaptation to be established separately. Other components of the F/S will include the analysis of rainfall and runoff while factoring in climate change, a review of the runoff model adopted in the master plan, and possible revision of the design high water discharge.

Source: AMDA Journal
http://amda.or.jp/old/journal/emergency/0307-15.html

Case Study (Flood Forecast/Warning and Evaluation): Project on Capacity Development for Disaster Risk Management in Central America "BOSAI" (2007-2012)

In this project, JICA has been providing technical assistance since 2007 for improving the disaster management capacity of communities and local governments in six Central American Countries, namely, El Salvador, Guatemala, Costa Rica, Nicaragua, Panama, and Honduras.

When Hurricane Ida hit El Salvador in November 2009, extreme torrential rain that was so heavy it may be described as a once in a hundred years event triggered floods and debris flows in many parts of the country, leaving many casualties. In Las Hojas, one of the Project Areas, villagers successfully evacuated, with no fatalities.

Community Survey (Honduras)
Source: Project on Capacity Development for Disaster Risk Management in Central America "BOSAI"

Successful evacuation was made possible due to an early warning. The disaster management committee of San Pedro Masahuat city was notified by communities in the middle and upper reaches of extraordinarily heavy rain there. The committee wasted no time in informing the disaster committee of Las Hojas village. Village officials in charge activated the nine sirens of the flood early warning system as early as two hours before the flood struck the village and urged villagers to evacuate.

The establishment of the disaster management committees of the city and the village, and the provision of radios and sirens were all part of this project. It is also worth noting that a member of the city disaster management committee was a former participant in JICA's training program on disaster management. He played an important role in these emergency responses, including evacuation. According to a field survey on the effectiveness of the project, some 50% of the 94 families in the village evacuated after hearing the siren, and 20 of these families had taken part in a workshop or other activities under this project. This suggests that these families played a leading role in the evaluation of local villagers.

Case Study (Flood Forecast/Warning and Evaluation): JICA Comprehensive Study on Disaster Management in Sri Lanka (2006-2009)

On the late night of November 22, 2007, some parts of Nagalakanda village, one of the pilot communities, was struck by sediment hazards triggered by heavy rainfall. Villagers had earlier escaped unharmed.

This project was behind the successful and timely evacuation. On November 18, prior to the disaster, residents of the afflicted area participated in a JICA workshop on early warning and learned what to do in an emergency. On November 22, they noticed that the observed rainfall exceed the critical level and contacted the competent agency for instructions in accordance with the prearranged procedures. In this way, they successfully evacuated to the pre-designated site.

Disaster prevention awareness workshop in a school
Source: Comprehensive Study on Disaster Management in Sri Lanka

Case Study (Community-Based Disaster Management): JICA Assistance to Community-Based Disaster Management in Morocco

Implementation of a Pilot project

To verify the validity of the plan for a flood forecast and warning system, a pilot project was implemented. In the project, JICA introduced the system in a river basin and operated it on a trial basis. It also organized three evacuation drills for local communities in the basin. During each drill, local government officials and the JICA study mission explained the mechanisms of natural disasters to local people in an easy-to-understand manner (such as explanation using a debris flow model kit) After these three drills, the JICA mission arranged an evaluation forum in which local people, provincial government representatives, and the mission discussed gaps and opportunities for improvement.

Behavioral changes in the local government and communities though JICA's development study

(i) Cooperation between the local government and the communities

Consultations between the local government (province) and communities at such opportunities as the evacuation drill evaluation forum allowed both sides to recognize the importance of cooperation and coordination between them. At the suggestion of the provincial governor, both sides agreed to hold regular meetings on disaster preparedness. This partnership provided an opportunity for the local government and communities to discuss regulating the entry of vehicles into the river basin during a disaster in order to reduce damage.

(ii) Awareness-raising of communities about disaster preparedness

Some local people who participated in an evacuation drill thought they wanted to do something about disaster reduction. In the spring of 2003, they relaunched a local NGO for environmental protection and tourism promotion, which had been in a dormant state, to incorporate disaster preparedness into the NGO activities. This NGO called on local people to take part in evacuation drills. As a result, many people in the basin, including local women and children, as well a people from other basin and even tourists, came to participate in these drills.

Such active participation in evacuation drills helped raise the awareness of local people about disaster preparedness. In 1995, a devastating flood struck this river basin, leaving more than 100 people dead. Most of them were tourists who failed to evacuate quickly enough. In contrast, when a heavy flood hit the area in 2003, no one was killed, thanks in large part to the nimble response of local people, who guided the tourists' vehicles to safer places. These local people later told the JICA mission that they have an Arabic tradition of mutual-help. It may be safe to conclude that the evacuation drills developed their intrinsic capacity.


Tourists along riverside
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No fatalities were reported when a heavy flood struck this basin again three years later (in 2006), due largely to timely evacuation action. The media described this as a major achievement of Japan's development assistance.

Case Study (Coastal Erosion Control): JICA's Feasibility Study on the Urgent Bali Beach Conservation Project, and the Bali Beach Conservation Project, an ODA loan project[57]

Background

Bali was experiencing environmental degradation. Disorderly development was giving rise to the disappearance of white beaches and coral reefs, which constituted valuable tourism resources of the island. It was also causing damage to coastal structures. To make matters worse, inadequate responses, including shore protection works by the Indonesian government, exacerbated rather than slowed the process of beach disappearance. This landscape damage was raising the prospect that the island would impair its value as an international tourist resort. To help rectify the situation, JICA formulated a project to conserve Kuta, Nusa Dua, and Sanur beaches, as well as Tanah Lot Temple on the island cliff facing the Indian Ocean, based on this feasibility study. The project was later implemented under an ODA loan scheme.

Coastal conservation plan

(1) Basic policy

The basic policy was to implement beach replenishment work to protect the hinterland from erosion and scouring, and to restore eroded beaches, install headlands, offshore breakwaters and other structures designed to reduce sediment transport along the shoreline in order to maintain sand supply for beach replenishment.

(2) Specific measures

A) Facilities planning (estimating effectiveness through hydraulics model tests and numerical simulations)
   - (i) Kuta beach: Beach replenishment (2.7 km in length, 50 m in width (average), with a sand volume of 783,000 cu m); breakwaters (4 T-shaped groins, 1 straight groin)
   - (ii) Nusa Dua beach: Beach replenishment (2.35 km in length, 50 m in width (average), with a sand volume of 229,000 cu m); breakwaters (extension of the existing 1 offshore breakwater and 3 groins)
   - (iii) Sanur beach: Beach replenishment (0.7 km + 4 km in length, 30 m in width (average), with a sand volume of 96,000 cu m + 352,000 cu m); breakwaters (3 sets of headlands, 4 straight groins, 1 L-shaped groin + 1 straight groin), 1 submerged breaker
   - (vi) Tanah Lot: Mount covered with natural stone and concrete blocks will be installed around the reed island.

B) Non-structural measures
   Developing a shore maintenance entity, setting up a maintenance office, and maintaining the shores

Project implementation

The project was implemented between 1997 and 2008. The white sand beaches were restored in the three areas. At Tanah Lot, artificial reef works whereby wave dissipation blocks were sunk offshore were adopted. The rocky cliff itself was reinforced with rock simulation work to respect the natural landscape. On the Kuta coast, a coral transplant and propagation project was implemented to restore the coral reef that had been badly damaged in the past.[59]

Recovered sandy beach
Source: Plaza for International Cooperation
http://www.apic.or.jp/plaza/oda/story/20100201.html

6-3 Terms of Reference and PDM (sample)

Terms of Reference (example) --Preparatory Study (ODA loan)--

II. Purpose of the Study and Matters Related to the Contents

1. Background to the Study and Project Summary, etc.

[Background to the Study]

Country XXXX [enter the formal name of the country] (hereinafter referred to as "X" [enter the short name of the country] has been experiencing a series of severe natural disasters. This has prompted the Government of X to set out a policy to strengthen its national disaster management framework and has become committed to disaster impact reduction measures [specify how].

Under these circumstances, JICA has conducted a development study called the "Study on ZZZ [specify the theme]" between mm/yy and mm/yy. This development study comprises the following components: (i) formulation of a master plan for flood control for four rivers in the southwestern region of X; (ii) capacity building for the operation of forecasting and warning systems; (iii) community-based disaster management; and (iv) capacity building for the government offices concerned (regarding the operation of the equipment required for communication, technology transfer regarding responses and management at the time of a disaster. In parallel with this development study, grant aid has been provided to scale up or replace the existing weather observation equipment and [specify the results].)

At the moment, the type of disaster that occurs most frequently and incurs the greatest social and economic losses is flooding. The Study on ZZZ, which recognizes the need for addressing both the structural and non-structural aspect of flood control, recommends selecting and promptly implementing a priority project that focuses on short-term measures for the basins of the four major rivers in the southwestern region of X, namely the AAA River, BBB River, CCC River, and DDD River, including measures to reinforce the existing facilities. In recent years, it has been predicted that increasing rainfall and changing rainfall patterns due to climate change will increase the frequency and intensity of flood disasters. In addition, accelerating population growth in the vicinity of cities or urban sprawl will aggravate such disasters, contributing to slowing economic activity and hampering the sustainable development of the country. It is therefore increasingly necessary to take a comprehensive flood mitigation approach that encompasses structural measures, weather forecasting, the issuance of disaster warnings based on weather forecasts, communication with disaster-vulnerable areas, evacuation responses at the time of a disaster, and community-based disaster management.

In XX/YY [specify the month and year], JICA sent a preparatory study mission to X for consultations on the implementation of this preparatory study and its outline and concluded a memorandum on the discussions with the Government of X. The purpose of this preparatory study is to develop a comprehensive flood mitigation solution, a solution that is proposed in the master plan formulated in the Study on ZZZ as a priority project in one of the four river basins in the southwest region--which are among the most flood-prone basins in the country--and a solution that adequately combines the structural approach with the non-structural approach (as exemplified by the above-mentioned measures, including forecasting and warning, community-based disaster management, and basin management) and to conduct a feasibility study with a view to formulating an ODA loan project in the future.

[Project Summary]

(1) Overall Goal

………To reduce flood hazards in four flood-prone basins in southwestern X by promoting the development of river and flood control infrastructure <u>while adapting to climate change</u>

(2) Project Purpose

………The project aims to conduct a feasibility study after reviewing the components of the priority project regarding measures for climate change adaptation and flood mitigation (structural and non-structural measures) in the BBB River basin (spanning JJJJ, KKKK, and LLLL provinces [specify the provinces]) in southwestern X and while promoting capacity development for the competent agencies; and to develop a capacity building plan for river administration. The relevance of this project is determined in relation to other projects to be formulated for three other river basins (AAA, CCC, and DDD [specify the rivers]).

(3) Outputs

(i) The components of the priority project in the BBB River basin (work-type, alignment, and scope of each structure) will be identified after reviewing hydrologic and hydraulic conditions.

(ii) The rehabilitation plan for the existing structures that also encompasses replacement and construction will be formulated to improve their flood management capacity in the AAA, CCC, and DDD river basins.

(iii) Non-structural measures will be formulated, and a plan to improve the relevant organizational and regulatory frameworks (notably land use regulation) will be proposed and incorporated into X’s authorization process.

(iv) For the four major river basins in the southwestern region, <u>the outputs of the designated global climate models will be used to project changes in the rainfall pattern (precipitation, rain intensity, etc.)</u>

(v) A basin council will be established in the BBB River basin to mediate the conflicting interests among the stakeholders toward project implementation.

(vi) The capacity and institutional strengthening plan for river administration will be formulated.

(vii) The capacity building of the implementing agency for flood management and climate change adaptation will be supported through the above-mentioned activities.

(viii) An ODA loan project will be formulated with its feasibility assessed through economic assessment and EIA studies, based on the plans proposed in (i)-(vi).

(4) Plans for activities and inputs

(5) Project site

(6) Beneficiaries

(7) Implementing agency of the partner country

2. Purpose of the Study

In this study, JICA will, based on the agreement in the MOD, conduct a feasibility study on the short-term measures (structural and non-structural) for climate change adaptation and flood control in the BBB River basin--to which top priority has been given among the four flood-prone river basins (AAA, BBB, CCC, and DDD rivers) in the southwest region--that have been proposed in the master plan. As for the other rivers, [specify the action] will be taken. JICA will offer recommendations and advice on the institutional framework and policies for project implementation. It will support the establishment of a basin council in the BBB River basin, help coordinate conflicting views among the stakeholders, and assist in building capacities for formulating, revising and implementing the project. Regarding flood mitigation, JICA will put forward a policy and institutional development plan for coping with changes in flood discharge due to a changing climate.

3. Study Area

AAA, BBB, CCC, and DDD river basins in Country XXXX

4. Study of Policies and Important Considerations

(1) Matters related to the contents of the study

Because the Study Area spans four river basins, this study will comprise four components, the classification of which (plans to be formulated) is shown below:

- Component 1: a short-term plan for climate change adaptation and flood mitigation for the BBB River
- Component 2: a rehabilitation plan for flood control facilities for AAA, CCC, and DDD rivers
- Component 3: a rehabilitation plan for drainage pump stations for CCC and DDD rivers
- Component 4: a plan for functional scaling-up and improvement of river administration

This technical cooperation project will conduct a range of activities aimed at supporting the capacity development of disaster management organizations in X. The planned components of the technical cooperation project, in relation to this study, include providing technical support to DOM for weather forecasting, promoting community-based disaster management in flood-prone areas, supporting coordination between MMC and DNN, and improving the capacity of MMC to communicate disaster information (including flood information) to local governments. While taking the importance of capacity development into consideration, this study will avoid duplication with these components. For greater efficiency, this study will seek to coordinate with other technical cooperation projects and with C/P agencies in X as appropriate.

(2) The study and the project implementation framework

(3) Considerations for capacity development

(4) Relationship with plans for dams upstream

(5) Identifying the optimal flood control approach in the light of climate change

JICA will take a multi-tier approach to selecting flood control components, while taking into account such factors as flood hazard areas, assets, the population, and project scale. It may be useful to divide the basin into three types of areas: (i) areas that must be protected with structures; (ii) those that can accept inundation and embrace crisis management; and (iii) those that restrict development. For the purpose of disaster reduction, it will study a levee structure, including the levee alignment, that is designed to minimize hazards in the case of a levee breach and consider its effective combination with non-structural measures, notably community-based disaster management.

(6) Formulating projects for coordination with urban development

(7) Appropriately assessing existing structures and identifying the parts that need renovation

(8) Identifying important considerations in project implementation

(9) Establishing a basin council

(10) Studying ways to scale up and improve river administration

(11) Climate change projection and adaptation planning

There are no established methods for projecting changes in rainfall or planning for adaptation. JICA will conduct the study while obtaining guidance from academics. Structural measures for adaptation such as levee construction have their limitations. Coordination with non-structural measures such as regulating land use and developing a warning and evacuation framework, as well as with community-based disaster management, is crucial. JICA will factor in climate change risks in project designing and formulating processes, such as the process of reviewing the priority project and conducting an F/S, and the process of determining the scale and components of the subsequent project, whether it is engineering-oriented or not.

For the purpose of an F/S, this study will project future rainfall using the ensemble method and conduct the downscaling* of the outputs of global climate models (GCMs) to the Study Area with input from JICA's working group on climate change adaptation. With the overall study process taken into account, the required data, the schematic flow diagram, the duration, the implementation period and other matters should be presented in the proposal.

* Downscaling is a process of the spatial refinement of climate data using statistical methods and physics. Many GCMs use a 250-km mesh and are therefore unable to represent the local climate. This calls for the spatial refinement of GCM data and the development of a climate model with a finer resolution.

(12) Studying effective options for regulating land use

(13) Studying the resettlement option

(14) Design and cost estimation

(15) Preparing and submitting reference materials as called for under the total ODA cost improvement program

(16) Public relations

5. Scope and duration of the study

…………………

6. Contents of the study

(1) 1st year

[1st work in Japan: late MM/YY]

A. Operation planning
B. Explanation of the draft inception report (IC/R) to JICA

[1st work in the partner country: MM/YY - MM/YY]

(Expected tasks in the first half of the first work in partner country)

C. Explanation of the draft inception report to the Government of X and consultations
D. Collecting and organizing existing data

Tasks for Component 1

E. Cross sectional surveys of rivers and soil surveys (local sub-contracting)
F. Establishment and management of a basin council
G. Study the basic policy on flood management that factors in climate change adaptation
   The basic policy may encompass the integration of urban facilities planning and flood control in urban areas; the selection of protection areas, including damage estimation, in rural areas; and options to selectively protect critical facilities and population centers.
H. Collecting and organizing the hydraulic data necessary for climate change analysis; rainfall and runoff analysis
   Downscaling for climate change analysis should be implemented with advice from JICA's working group on climate change adaptation. The hydraulic data required for downscaling (rainfall and other climate data) will be collected from the weather bureau of X. Impact projections will be made for each basin. Specific steps will include providing up-to-date hydrological values, conducting rainfall and runoff analyses, reviewing the runoff model that was adopted in the master plan (basin segmentation, parameters, etc.), and revising the design high water discharge.
I. Reviewing the plan for scaling up the flood forecasting and warning system (common to Components 1 and 2)
J. Confirming the regulatory framework on land use regulation (common to Components 1 and 2)
K. Reviewing the achievements of community-based disaster management (common to Components 1 and 2)
L. Environmental and social considerations for the selected Project Areas (common to Components 1, 2 and 3)
   (1) Confirming the environmental impacts
   (2) Assuring social considerations

Tasks for Component 2

M. Surveying the current condition of existing flood control structures
N. Studying the design flood level
   ………Reviewing the results of runoff analysis in the master plan while taking climate change impacts into account and examining the high water discharge. Then making hydraulic calculations using the up-to-date cross section of the river obtained by Task E above, calculating the water level at the point of each structure, and determining the design high water level.

Tasks for Component 3

Tasks for Component 4

(Expected tasks in the second half of the first work in the partner country)

Tasks for Component 1

O. Inundation analysis and flood control benefit analysis
These steps include preparing a damage estimation for the BBB River basin, conducting an inundation analysis to design adaptation measures to reduce the estimated damage, and collecting and analyzing data on [specify].

P. Formulating a short-term plan for climate change adaptation and flood mitigation for the BBB River
Based on the results of Task O, the levee alignment and structure will be identified (and so will the sections to be inundated and residential areas and critical facilities to be protected). In the process, the number of buildings to be relocated as a result of levee construction will be calculated (including the number of buildings to be replaced by new levees and the number to be left in the floodplain).

Q. Formulating the plan for scaling up the flood forecasting and warning system (common to Components 1 and 2)
Based on the study results so far, a plan for scaling up the flood forecasting and warning system will be formulated.

R. Promoting development planning that factors in disaster management, and the regulation of development (common to Components 1 and 2)
………Specific land use options that complement Task J and structural measures in both the BBB and AAA river basin for improved effectiveness will be proposed.

S. Developing a plan for community-based disaster management (common to Components 1 and 2)
A plan for community-based disaster management will be developed that addresses the gaps identified in Task K.

Tasks for Component 2
Tasks for Component 3
Tasks for Component 4

[2nd work in Japan: MM/YY - MM/YY]
(2) 2nd year

[2nd work in the partner country: MM/YY - MM/YY]

[3rd work in Japan: MM/YY]

[3rd work in the partner country: MM/YY]

[4th work in Japan: MM/YY]

7. Report documentation procedures

III. Operational requirements

1. Study process: mid MM/YY - early MM/YY

2. Estimated personnel and fields of expertise

The fields of expertise and estimated personnel required for the operations are summarized below:

(1) Mission members
1) Leader / river plan / climate change adaptation

2) Sub-leader / river structures
3) Hydrology / hydraulics / climate change projection
4) Soil/material
5) Machinery and equipment planning (drainage pump stations)
6) Electric equipment planning (drainage pump stations)
7) Environmental considerations
8) Social considerations
9) Flood forecasting/evaluation arrangements
10 Non-structural measures/land use
11) Community-based disaster management
12) Execution planning/cost estimation
13) Economic analysis/project valuation
14) Organizational and regulatory frameworks

(2) Estimated manpower Total M/M (of which the 1st year: about M/M)

● Tasks for each consultant

1) Leader / river plan / climate change adaptation: Responsible for the overall management of the mission, including process control and negotiations, as we have for river planning (entailing structural measures) and planning climate change adaptation
2) Sub-leader / river structures :
3) Hydrology / hydraulics / climate change projection: Chiefly responsible for hydrologic and hydraulic analysis and climate change impact projection
4) Soil/material :
5) Machinery and equipment planning (drainage pump stations) :
6) Electric equipment planning (drainage pump stations) :
7) Environmental considerations :
8) Social considerations :
9) Flood forecasting / evaluation arrangements :
10) Non-structural measures / land use :
11) Community-based disaster management :
12) Execution planning / cost estimation :
13) Economic analysis / project valuation :
14) Organizational and regulatory framework :

(3) Operations coordinator

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