People's Republic of Bangladesh

Data Collection Survey on Strengthening of Disaster Tolerance in Cyclone Affected Area

Final Report

Summary

August 2012

JAPAN INTERNATIONAL COOPERATION AGENCY

ORIENTAL CONSULTANTS CO., LTD.

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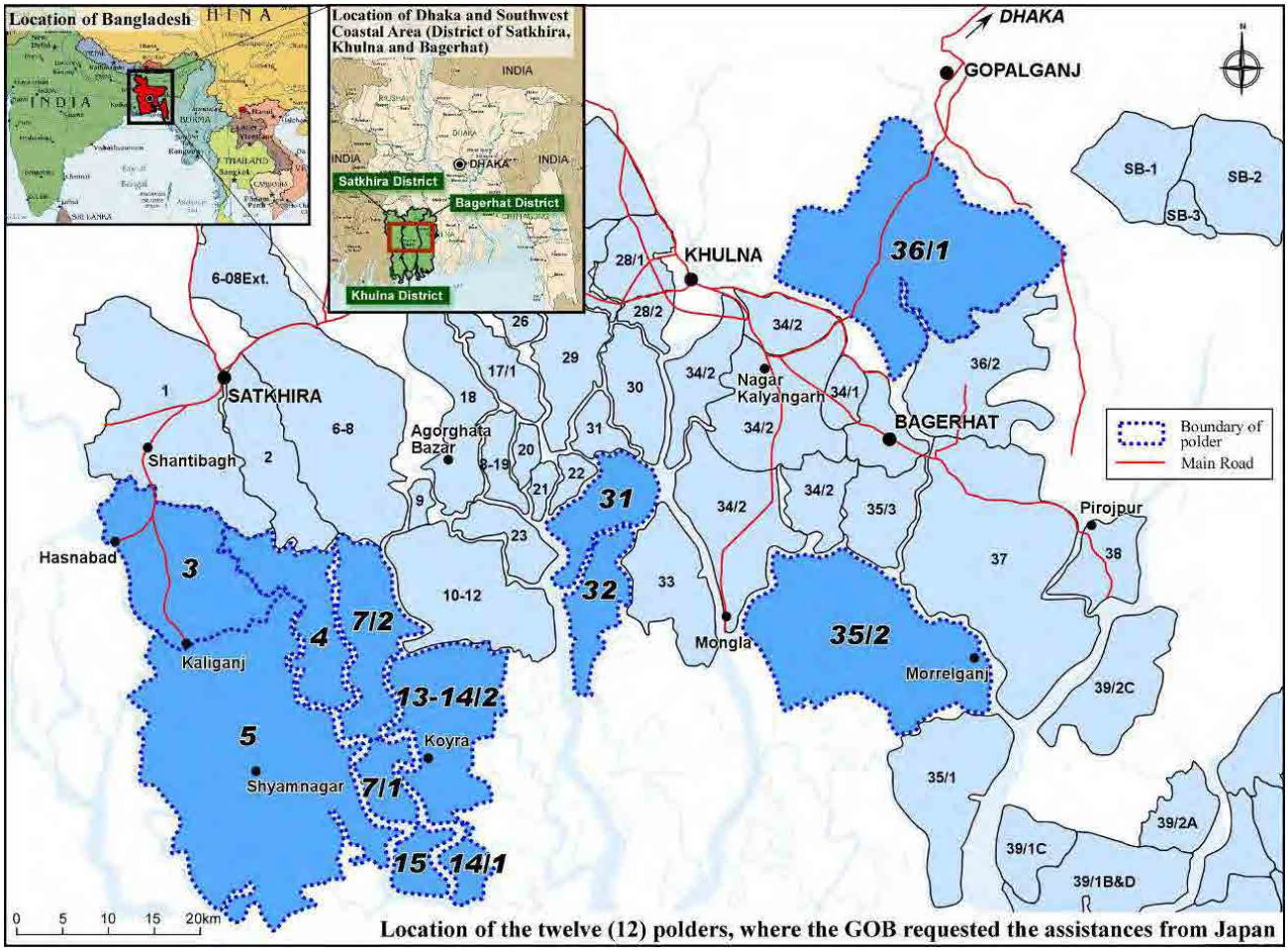
Foreign Currency Exchange Rates Applied in the Survey

Currency	Exchange Rate/USD
Bangladesh Taka (BDT)	77.99 BDT
Japanese Yen (JPY)	79.26

(June, 2012)



Location Map of Survey Area

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Abbreviations

ADB	Asian Development Bank
AusAid	Australian Agency for International Development
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BDPC	Bangladesh Disaster Preparedness Centre
BDRCS	Bangladesh Red Crescent Society
BMD	Bangladesh Meteorological Department
BWDB	Bangladesh Water Development Board
CCDMC	City Cooperation Disaster Management Committee
CEGIS	Centre for Environmental and Geographic Information Services
CEIP	Coastal Embankment Improvement Project
CIF	Climate Investment Fund
CDMP	Comprehensive Disaster Management Program
CDS	Coastal Development Strategy
CPP	Cyclone Preparedness Programme
CPPIB	CPP Implementation Board
CZPo	Coastal Zone Policy
DDCC	District Development Coordination Committees
DECC	Disaster, Environment and Climate Change
DG	Director General
DMB	Disaster Management Bureau
DMC	Disaster Management Committee
DPHE	Department of Public Health Engineering
DRR	Disaster Risk Reduction
DRRO	Disaster Relief & Rehabilitation Office
ECRRP	Emergency Cyclone Recovery and Restoration Project
EPAC	Earthquake Preparedness and Awareness Committee
ERF	Early Recovery Facility
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
FFWC	Flood Forecasting & Warning Center
GIS	Geographic Information System
GoB	Government of Bangladesh
GoJ	Government of Japan
IMD	India Meteorological Department
IMDMCC	Inter-Ministerial Disaster Management Coordination Committee
IPSWAM	Integrated Planning for Sustainable Water Management Program
IT	Information Technology
IWM	Institute of Water Modeling
JICA	Japan International Cooperation Agency
LGED	Local Government Engineering Department
ME&DD	Mechanical Equipment & Dredger Directorate
MoE&F	Ministry of Environment & Forests
MoHFW	Ministry of Health & Family Welfare
MoWR	Ministry of Water Resources
NAPA	National Adaptation Program of Action
NDMC	National Disaster Management Council
NDRCG	National Disaster Response Coordination Group
NGO	Non-Governmental Organizations
NPDM	National Plan for Disaster Management
NPDRR	National Platform for Disaster Risk Reduction
NWMP	National Water Management Plan

NWP	National Water Policy
PPCR	Pilot Program for Climate Resilience
RFP	Early Recovery Facility
RS	Remote Sensing
RRI	River Research Institute
SAIWRPMP	South-West Area Integrated Water Resources Planning and Management Projects
SCF	Strategic Climate Fund
SFYP	Sixth Five Year Plan
SOD	Standing Orders on Disaster
SPCR	Strategic Program for Climate Resilience
SRDI	Soil Research Development Institute
SWC	Storm Warning Centre
TRM	Tidal River Management
UDCC	Upazila Development Coordination Committees
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
WARPO	Water Resources Planning Organization
WASA	Water and Sewerage Authority
WB	World Bank

1. Introduction

1.1 Background of the Survey

Total population in Bangladesh (2011) is 140 million, and approximately 35 million habitants live in the coastal area. Especially along the river mouths, there are many sand bars accumulated from upstream sands, and approximately 70 polders have been produced around each sand reef. Most of the polders in the coastal area are located in Brackish areas with two functions which are river dikes and tide embankments to seaside. After 1970, large-scale cyclones occurred 15 times, and many lives were lost. Especially in 1970, cyclones caused more than 300 thousand deaths. Since then, the number of annual disaster victims has decreased due to the efforts of the Government of Bangladesh (GoB), supported by international assistance organizations such as Japan International Cooperation Agency (JICA) and non-governmental organizations (NGO). Such efforts include: construction of evacuation shelters, dikes and embankments, establishment of early warning systems and weather radar networks, revival of mangrove forests for land protection, improvement of emergency response activities, and strengthening of school education on disaster risk reduction, *etc*.

However, in recent years, two consecutive large-scale cyclones have resulted in serious damage to the coastal areas. The cyclone "SIDR" in November 2007 caused more than 3,000 deaths. The cyclone "AILA" in May 2009 brought more damage in southwest areas, affecting lives, houses, and life infrastructure including approximately 3.9 million habitants suffered, some 200 deaths, some 600 thousand houses damaged by tidal surge, complete collapse of embankments with the length of 213 km, and partially damaged embankments with the length of 1,128 km. More than half of the polders were inundated by seawater, resulting in damage to farmlands, housing areas, and public facilities.

Although most of the polders in damaged areas have been rehabilitated, it is still being undertaken as emergency measures, not fundamental measures for preventing cyclone and tidal surge. Even now, some southwest coastal areas remain inundated and there are many residents without homes. It is necessary to provide not only life support to habitants, but full rehabilitation and additional development of hard components such as embankments as well as formulation of evacuation systems to improve the capacity for disaster prevention.

In these circumstances, the Bangladesh Water Development Board (BWDB) has requested assistance from the Government of Japan (GoJ) to rehabilitate the infrastructures in six (6) polders in the southwest coastal area where the damage was severe. The GoJ has not yet provided any assistance to the subject areas for rehabilitation; therefore, the Survey Team has been dispatched to carry out the "Data Collection Survey on Strengthening of Disaster Tolerance in Cyclone Affected Areas" (hereunder, "The Survey") prior to consideration of necessary assistance in the area.

1.2 Objectives of the Survey

Objectives of this Survey are as follows:

- To identify the countermeasures (target areas, budgets, and schemes) provided by the international aid agencies/NGOs to the disaster affected areas, to investigate the restoration status of the infrastructures (dikes, embankments, *etc.*), conditions of farmlands, residential areas, and public facilities in the polders, and to define challenges on water-related disaster (*e.g.* cyclones, storm surges, *etc.*) and risk reduction in the coastal areas in Bangladesh.
- To develop and present necessary measures for improving capacity for water-related disaster risk reduction (not limited to JICA assistance).

- To propose the possible direction, schemes, and target areas for future JICA's cooperation, based on above proposed measures.

1.3 Survey Area

The target Survey areas are located in the southwest coastal areas where the damage was severe (Districts of Khulna, Bagerhat, and Satkhira). Specifically, the following six (6) polders, requested by the GoB as high priority locations for grant aid assistance (dated on August, 2010) are the main areas of concern: 1) Polder No.32, 2) Polder No.15, 3) Polder No.7/1, 4) Polder No.7/2, 5) Polder No.13-14/2 and 6) Polder No.14/1. As per a request from the BWDB district offices (Khulna-2, Satkhira-1, Satkhira-2 and Bagerhat) to add six (6) more polders, a total of 12 polders have been targeted for the survey area. Refer to "Location Map of Survey Area" at the beginning of this report.

Table 1-1 Targeted Survey Area (Name of Polder)

BWDB office	Name of Polder※
Khulna-2	『***31***』, 『32』
Satkhira-1 & 2	『***3***』, 『***4***』, 『***5***』, 『7/1』, 『7/2』, 『13-14/2』, 『14/1』, 『15』
Bagerhat	『***35/2***』, 『***36/1***』

Note: The additional requested polders by BWDB offices are shown with bold and italic style

1.4 Team Members

Survey team is composed of the following five (5) members.

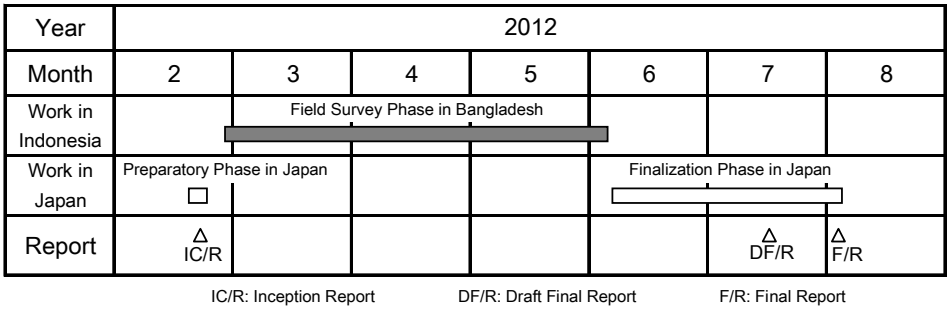
Table 1-2 List of Survey Members

(1)	Team Leader/Water Related Disaster Management	: Mr. Kenichiro KATO
(2)	Structure Countermeasures (Dike & Embankment)	: Mr. Toshinori OSHITA
(3)	Water Resources Management/Flood Control	: Ms. Ikuko KUNITSUKA
(4)	Community-Based Disaster Risk Reduction (1)	: Dr. Naonori KUSAKABE
(5)	Community-Based Disaster Risk Reduction (2)	: Ms. Rumi HORI (SAWADA)

1.5 Schedule

This survey is implemented for six (6) months from February to July in 2012. The survey implementation schedule is shown as follows.

Table 1-3 The Survey Implementation Schedule



2. Current Status of Countermeasures against Cyclone Disaster in the Coastal Areas in Bangladesh

2.1 Bangladesh's Upper Level Long Term Plan, Strategy and Master Plan on Disaster Management in the Coastal Areas

Upper level long term plans for disaster measure in the coastal areas of Bangladesh are summarized in Table 2-1.

Table 2-1 Upper Level Long Term Plan in Terms of Disaster Management in Coastal Areas of Bangladesh

Outline Perspective Plan 2011-2021	Upper level long term plan of Sixth Five Year Plan (FY2011-FY2015) and Seventh Five Year Plan (FY2016-2020)
Sixth Five Year Plan 2011-2015	Sixth Five Year Plan (FY2011-FY2015) at national level aiming at "Accelerating Growth and Reducing Poverty"
National Water Policy (1999)	Policy for appropriate development and management of water resources. Framework of national water-management plans
National Plan for Disaster Management (2010)	First national plan of disaster management for medium and long term in Bangladesh
Standing Orders on Disaster (2010)	Standing orders for roles and responsibilities of governmental and related organizations
Coastal Zone Policy (2005)	Policy aiming at poverty reduction, environmental protection and sustainable living improvement in coastal areas as well as creation of national comprehensive development processes
Coastal Development Strategy (2006)	Coastal development strategy formulated by MOWR based on the "Coastal Zone Policy (2005)"
Bangladesh Climate Change Strategy and Action Plan 2008	Strategy for management of climate change and its impact in Bangladesh
Strategic Program for Climate Resilience (SPCR)	Strategic program for climate resilience at national level in medium and long term formulated in 2010

Source: JICA Survey Team

2.1.1 Outline Perspective Plan of Bangladesh 2011-2021: Making Vision 2021 a Reality

The "Outline Perspective Plan of Bangladesh 2011-2021" notes issues and necessary processes to achieve the development objective "Vision 2021" by 2021 in Bangladesh. The plan will be implemented through the Sixth Five Year Plan (2011-2015) and the Seventh Five Year Plan (2016-2020) with two steps based on medium term development plans.

In priority issues, main strategies in terms of disaster management, water resources, and climate change are shown as follows.

Table 2-2 Strategies for Issues on Disaster Management, Water Resources and Climate Change

- Follow the IWRM framework for best allocation of water to various uses;
- Encourage research and development in designing appropriate activities to manage climate change impacts on and through the water sector;
- Encourage research on crop varieties that are water efficient and resistant to salinity;
- Focus on surface water irrigation and stabilize reduced use of groundwater;
- Increase irrigation efficiency and reduce wastage and losses through better technology and better management;

- Encourage greater use of rainwater and its local storage for use in the dry season;
- Develop and implement efficient and effective measures to reduce the knowledge gap of farmers on Farm Water Management technology;
- Examine large-scale O&M activities in embankments and polders to prevent salinity intrusion along the coast, and identify and implement the best option for the purpose; Undertake desalinization activities;
- Rehabilitation of coastal embankments to help adapt to climate change;
- Protection from river erosion of water courses and enhancement of land reclamation
- Undertake planned and phased dredging and river training activities;
- Examine the government's water sector agencies and institutions and, if necessary, redesign, reorient and further equip them for more effective implementation of policies and strategies;
- Negotiate with India for equitable water sharing arrangements for all transboundary rivers, particularly major rivers;
- To improve navigability and water discharge and reduce flood risks, a strategy of dredging and training of rivers in a planned and phased manner
- Strengthen afforestation, particularly in coastal areas in terms of strategic locations and overall area covered;
- Strengthen and properly implement the policy of crop diversification to reverse the land degradation process;
- Implement and promote the strategy for integrated coastal zone management(desalinization of water and land in coastal zones); and
- Undertake the adaptation activities, both structural and non-structural measures, to protect the people and equip and Examine O&M and rehabilitation activities for embankments and polders to prevent flood water and salinity intrusion.

Source: Outline perspective Plan of Bangladesh 2011-2021

2.1.2 Sixth Five Year Plan (SFYP) 2011-2015

One of the medium development plans is the "Sixth Five Year Plan (SFYP) 2011-2015" based on the "Outline Perspective Plan of Bangladesh 2010-2021: Making Vision 2021 a Reality". The "SFYP 2011-2015" is the sixth five year plan covering the period from 2011 to 2015, and its development objectives are based on the "Vision 2021" and "Millennium Development Goals (target year 2015).

Disaster Management

Objectives and strategies for reduction of disaster risks in "SFYP" 2011-2015" are shown as in the following Table 2-3.

Table 2-3 Objectives and Strategies for Reduction of Disaster Risks in "SFYP" 2011-2015

- Integrating disaster risk reduction and climate change adaptation approach in all ongoing and future development plans, programs and policies;
- Enhancing professional skills and knowledge of key personnel on disaster and climate change risk reduction, preparedness, warning and forecasting systems, and post-disaster activities;
- Strengthening mechanisms to build disaster and climate change risk reduction capacities for the Community and Institutions at all levels;
- Community based Programming for risk disaster and climate change risk reduction;
- Promoting livelihood strategies and options for the most vulnerable that incorporate disaster and

climate change risk reduction practices;
- Strengthening capacities for disaster and climate change risk assessment for flood, cyclone, drought, river bank erosion, pest attacks, earthquake, epidemics, *etc*. to establish and strengthen the systems and procedures for effective response management through;
- Creating a legal and institutional framework for effective response management;
- Strengthening national capacity for response management with emphasis on preparedness and support to disaster management committees at district, upazila and union levels;
- Improving the early warning and community alerting system;
- Strengthening search and rescue capabilities of relevant agencies;
- Introducing effective response management coordination mechanism including a relief management logistics system to handle different levels of emergency response; and
- Establishing an electronic based information management system.

Source: Outline perspective Plan of Bangladesh 2011-2021

Water Resources

Objectives and strategies for water resources management and development in SFYP 2011-2015 are shown as in the following Table 2-4.

Table 2-4 Objectives and Strategies for Reduction of Disaster Risks in "SFYP" 2011-2015

- People's participation in conforming with IWRM principals;
- Enhancing conveyance capacity of water courses through river dredging;
- Protection against river erosion;
- Land reclamation;
- Conjunctive use of surface and groundwater for sustainable irrigation;
- Optimum use of available flows of the common rivers for multipurpose use;
- Regional and International cooperation for basin-wide water resources development and management of trans-boundary rivers;
- Flood Control/ Flood Management;
- Heights of coastal and flood embankments to be raised;
- Food security by achieving food grains self-sufficiency through ensuring year-round sustainable irrigation;
- Water conservation for irrigation and other uses;
- Climate change adoption and mitigation;
- Environmental protection;
- Culture fisheries in the completed projects of BWDB;
- Integrated coastal zone management;
- Strengthening and capacity building of water resources institutions in the field of climate change issues, data management, river management, ICT arena; and
- Studies and research on future water resources management.

Source: Outline perspective Plan of Bangladesh 2011-2021

Climate Change

The following Programs related with climate change shown in Table 2-5 are planned to be implemented in "SFYP 2011-2015".

Table 2-5 Sixth Plan Benchmark and Proposed Target Programs

Theme	Program	Benchmark	Target
Food security, social protection and health	Institutional capacity for research and dissemination on climate resilient cultivars	Capacity exists; certain new varieties released recently	Extension service to be geared up
	Adaptation for drought, salinity resistance and heat	Very limited experience	To be started
	Adaptation in fisheries sector	Very limited experience	Initial studies for ideas on adaptation
	Adaptation in livestock sector	Very limited experience	Initial studies for ideas on adaptation
	Adaptation in health sector	Very limited experience	Initial studies for ideas on adaptation
	Water and sanitation programs for climate vulnerable areas	Limited experience	Immediate actions needed
	Livelihood protection in ecologically fragile areas	Little experience	Initial interventions to be made
	Livelihood protection of vulnerable socio-economic groups	Major experience	To be made immediately
Comprehensive disaster management	Improvement of cyclone and storm surge warning	Limited experience	Needs review for improvement
	Awareness raising and public dissemination	Some experience	Needs review for improvement
	Risk management against loss of income and property	Limited experience	Needs review and pilot intervention
Infrastructure	Repair and maintenance of existing flood embankments	Limited activity	To be taken up immediately
	Repair and maintenance of existing cyclone shelters	Limited activity	To be taken up immediately
	Repair and maintenance of existing coastal polders	Limited activity	To prioritize and taken up immediately
	Urban drainage needs assessment	Limited activity	To prioritize and taken up immediately
	Adaptation against Floods and constructing new embankments and flood shelters	Limited activity	Needs review for improvement & construction
	Adaptation against tropical cyclones and storm surges through land use planning	Limited activity	To be taken up immediately
	Planning & Design of river training and bank erosion mitigation works	Major experience with limited success	Needs review for significant improvement
	Resuscitation of rivers and khals through dredging	Limited activity	To prioritize and taken up immediately
	Earthquake resilient structures and land slide protected structures have to be constructed and retrofitted	Limited activity	To prioritize and taken up immediately
Research and knowledge management	National Centre for research, knowledge management and training on disaster and climate change	Limited activity	Scope to be extended immediately
	Climate change modeling and their impacts	Limited human and institutional capacity	Training to be arranged for imparting skill
	Preparatory studies for adaptation against SLR	Capacity exists, some technologies are in use	To be initiated and continued
	Research on the climate change adaptation for knowledge and technology generation	Capacity exists; some technologies are in use	To be expanded the scope and ongoing effort

Theme	Program	Benchmark	Target
Low carbon development	Renewable energy development	Limited experience	To be expanded
	Management of urban waste	Limited experience	To be taken up immediately
	Afforestation and reforestation	Some experience	To be taken up immediately
	Rapid expansion of energy saving devices	Some experience	To be taken up immediately
	Improving energy efficiency in transport sector	Limited experience	To be introduced in phases
Capacity building	Revision of sectoral policies for climate resilience	-	Immediate need
	Mainstreaming CC in national, sectoral and spatial development programs and policies	-	Immediate need; BCCSAP to be part of National Plan
	Strengthening human resource capacity	Limited capacity	To be started
	Gender considerations in CC	-	To be started
	Strengthening institutional capacity	Limited capacity	To be started
	Mainstreaming CC in media	Limited experience	To be started

Source: Sixth Five Year Plan FY2011-FY2015

2.1.3 National Water Policy (NWP)

The NWP is the policy of the Government of Bangladesh that ensures that all necessary means and measures are taken to manage the water resources of the country in a comprehensive, integrated and equitable manner approved by National Water Council in 1999. This guides management of the country's water resources by all the concerned ministries, agencies, departments, and local bodies that are assigned responsibilities for the development, maintenance, and delivery of water and water related services as well as the private users and developers of water resources.

The policies are set forth for addressing 16 elements such as river basin management, planning and management of water resources, water supply and sanitation, and so on

Table 2-6 Important Elements for NWP 1999

1. River Basin Management	9. Water and Fisheries and Wildlife
2. Planning and Management of Water Resources	10. Water Navigation
3. Water Rights and Allocation	11. Water for Hydropower and Recreation
4. Public and Private Involvement	12. Water for the Environment
5. Public Water Investment	13. Water for Preservation of Haors, Baors, and Beels
6. Water Supply and Sanitation	14. Economic and Financial Management
7. Water and Agriculture	15. Research and Information Management
8. Water and Industry	16. Stakeholder Participation

Source: NWP

The National Water Management Plan (NWMP) was formulated by the Water Resources Planning Organization (WARPO) in 2001 and approved in 2004 as the concrete implementation plan of NWP. NWMP are divided into three phases; the short term plan (2000-2005), medium term plan (2006-2010) and long term plan (2011-2025), monitoring the implementation situation and updated every five years. NWMP addresses the following three main issues within the background of socio-environmental circumstance such as population increase, population concentration into cities, arsenic contamination of water resources, flood with climate change and increase of drought risk.

- Appropriate utilization for reasonable management of water resources as well as experience and knowledge in Bangladesh

- Improvement of people's life quality by equitable, safe and reliable access to water, which is necessary for production, health and sanitation.
- Sufficient and appropriate water supply and protection for the water environment

2.1.4 National Plan for Disaster Management (NPDM) 2010-2015

"National Plan for Disaster Management (NPDM) 2010-2015" is a comprehensive disaster management plan for medium term disaster management (disaster risk reduction and prevention, enhancement of urgent response capacity, improvement of disaster recovery activities).

- The strategic direction for disaster management is based on national priorities and international activities
- Enable to Cleary explain the vision and objective of disaster management
- Indicate the strategic direction and priorities towards disaster management strategy and program formulation and implementation
- Establish the program framework for coordinating with government, NGO and private sectors.
- Reduce all disaster risks and establish the disaster management systems including emergency response measures
- Indicate Cleary how other ministries, NGO, public society and the private sector can contribute to the strategic implementation objectives and government vision.

NPDM identifies the disaster situation that has occurred in Bangladesh and future measures for main disasters.

Table 2-7 Main Disaster Situation and Necessary Measures

Type of Disaster	Disaster Situation / Necessary Measures
Floods	Floods are recognized as the main disaster in Bangladesh. The government has been developing and implementing various measures to reduce the flood damage. The Ministry of Water Resources (MoWR) is leading the country in flood mitigation initiatives, including the Flood Action Plan, Flood Hydrology Study, Flood Management Model Study, National Model Study, National Water Management Plan, National Water Policy, Flood Early Warning System, *etc*. Based on the flood management indicators, BWDB carefully monitors rainfall when flooding and/or water rising is occurring or imminent.
Cyclones and storm surges	The MoFDM activated emergency response committees at the District, Upazila, and Union levels and established an operations center in Dhaka to coordinate relief activities. Due to the increase in the population and the number of cattle heads, it has become essential to construct at least 2,000 disaster shelters and killas in coastal areas. The Ministry of Primary & Mass Education has taken up a programme under the project title "Primary Education Development Programme-2 (PEDP-2)"to construct 507 schools-cum-shelters in the coastal areas. It is expected that the other Ministries, Divisions, Organizations and NGOs will also construct about 300 shelters. In addition, the DM&RD has decided to construct the remaining 1,200 disaster shelters and killas.
Tornado	Well known nor'westers (kalbaishakhi) are generally associated with tornadoes from March to May in Bangladesh (When the winds become whirling storms with funnel shaped clouds having a speed of several hundred kilometres per hour, they are called tornados). Wind speeds in nor'westers usually do not exceed 113-130 km/hr, though often their speeds exceed 162 km/hr.
River bank erosion	Losses due to river erosion occur slowly and gradually, and they are more destructive and far-reaching than other sudden and devastating calamities. It takes a few decades to make up the losses that a family has incurred due to river erosion. Erosion of rivers in Bangladesh is extremely sensitive to changes in the river conditions. A study concluded in 1999 reported that: out of the 462 administrative units in the country, 100 were subject to some form of riverbank erosion, of which 35 were serious, and affected about 1 million people on a yearly basis. Around 10,000 ha land per year are eroded by rivers in Bangladesh (NWMP, 2001)

Type of Disaster	Disaster Situation / Necessary Measures
Earthquake	Bangladesh has long been one of the most seismically active regions of the world, and has experienced numerous large earthquakes. The record of approximately 150 years shows that Bangladesh and surrounding regions experienced seven major earthquakes (with Mb = 7 or greater)
Drought	As much as 17% of the Aman crops, the main paddy crops in the wet season, may be lost in a typical year due to drought in Bangladesh (especially in the northwest area). Drought affects not only seasonal crops, but also fruit-bearing trees, forestry and the environment as a whole. Moreover, the crop environment during the monsoon season is not favorable for achieving full potential yields because of uneven distribution of rainfall, flooding *etc*. To combat the drought, it is essential for Bangladesh to utilize its water resources, both surface and groundwater. However, Bangladesh has increasingly used her groundwater resources to such an extent that contamination is occurring at an alarming rate in the ground water reservoir due to over and unplanned withdrawal. Therefore, it is expected to utilize the surface water for protection against drought.
Arsenic contamination	Groundwater in 61 out of the 64 districts in Bangladesh is contaminated with arsenic. The maximum value for arsenic in drinking water as per the guideline of the World Health Organization (WHO) is 10 mg/L while the national standard in Bangladesh is 50 mg/L. According to a study conducted by the British Geological Survey and DPHE, out of the Bangladesh population of 125.5 million, up to 57 million people drink water that has an arsenic concentration greater than the WHO guideline value and up to 35 million people consume water that has concentrations in excess of the Bangladesh standard.
Salinity intrusion	Saline water intrusion is mostly seasonal in Bangladesh; in winter months the saline front begins to penetrate inland, and the affected areas rise sharply from 10 percent in the monsoon to over 40 percent in the dry season. In coastal districts such as Satkhira, Khulna, Bagerhat, agricultural production, fisheries, livestock, and mangrove forests are affected by higher salinity. High salinity both in monsoon and dry season in the southwest corner and along the Pussur-Sibsa system of the area is associated with the decreasing upstream freshwater flow as well as silting of major channels (WARPO, 2005).
Tsunami	After the Asia Tsunami 2004, considering the state of tsunami vulnerability and potential seismic sources, the Geological Survey of Bangladesh has divided the Bangladesh coastal belt into three zones. Bangladesh needs detailed surveys to scientifically assess its Tsunami vulnerability. Bangladesh also needs to develop a Tsunami early warning system and mass awareness of Tsunami threat in the coastal areas.
Landslide	Landslide is considered a major hazard after the Chittagong Landslide 2007 in Bangladesh due to the heavy rainfall during 10 – 11 June 2007). Landslides are a complex disaster phenomenon that can be caused by earthquakes, volcanic eruptions, heavy rainfall (typhoons, hurricanes), sustained rainfall, heavy snowmelt, unregulated anthropogenic developments, mining and others.
Others	Fire, Infrastructure collapse and so on

Source: NPDM 2010-2015

2.1.5 Standing Orders on Disaster (SOD)

"Standing Orders on Disaster (SOD)" is a disaster management regulatory framework for management of disaster risk in Bangladesh. It was published by the Disaster Management Bureau (DMB) in 1997 and revised in 2010. SOD is reflected in the "Disaster Management Act, National Disaster Management Policy, National Plan for Disaster Management and Guidelines for Government at all Levels (Best Practice Models) and describes the detailed roles and responsibilities of Committees, Ministries, Departments, and other organizations, community, officials of public organizations, and citizens involved in disaster risk management (disaster risk reduction, emergency response management and recovery).

According to SOD, the National Disaster Management Council (NDMC) is established with members including the prime minister as chairperson, related ministers, secretaries, government officials, and chairman of the military (land, sea and air) for disaster risk management. Under NDMC, the Inter-Ministerial Disaster Management Coordination Committee (IMDMCC) is established at the national level to facilitate policy making, planning, programming and implementing measures relating to disaster risk reduction and emergency response management in Bangladesh. IMDMCC is composed of the minister of MOFDM as chairman, cabinet

secretary as vice-chairman, and secretary of each ministry with responsibility for disaster management.

In addition, there are committees, councils and groups at national level such as the National Disaster Management Advisory Committee, Earthquake Preparedness and Awareness Committee (EPAC), National Platform for Disaster Risk Reduction (NPDRR), National Disaster Response Coordination Group (NDRCG), Cyclone Preparedness Programme (CPP) Policy Committee, and CPP Implementation Board (CPPIB), each given responsibilities and roles in terms of disaster risk reduction and emergency response for disaster risk management in SOD.

At the local level, the City Cooperation Disaster Management Committee (CCDMC) was established and has implemented all activities relating to urban disaster management (disaster prevention, disaster reduction, and advance preparation for disaster, emergency response and rescue in disaster). Also Disaster Management Committees (DMCs) are set up in each city, district, upazila, pourshava and union, indicating detailed responsibilities and roles and contents of activities for disaster management by DMCs of the city, district, upazila, pourshava and union the same as CCDMC.

2.1.6 Coastal Zone Policy (2005)

The Government of Bangladesh (Ministry of Water Resources: MoWR) formulated the "Coastal Zone Policy (CZPo) in 2005, aiming at poverty reduction, environmental protection and sustainable living improvement in coastal areas as well as creation of national comprehensive development processes including coastal areas. The CZPo is a principal of policy for integrated coastal zone management. Following this policy, all concerned organizations (Ministries, Agencies, Local Government Institutions, NGOs, the private sector and the civil society) needs to implement and manage the development of the coastal zone. A total of 19 districts are targeted as vulnerable coastal areas affected directly and indirectly by natural disasters such as salinity intrusion due to storm surges of cyclones.

Table 2-8 Disaster Management, Water Resources Management and Climate Changes by Coastal Zone Policy

Disaster management	• Reduce vulnerability to natural disasters and contribute to integral aspects of the national strategies for poverty reduction; • Implement the "Comprehensive Disaster Management Plan" in the aspects concerning the coastal zone; • Take effect measures to enhance the coping capacity of the poor during the disaster period and to implement an insurance scheme for improving their social security; • Take effective measures for protection against erosion and for rehabilitation of the victims of erosion; • Enhance safety measures by combining cyclone shelters, multi-purpose embankments, killas, the road system and disaster warning system including special measures for children, women, the disabled and the old; • Maintain sea dykes as the first line of defence against storm surges and implement afforestation on them according to the existing policy; • Strengthen earthquake management and capacity to cope with earthquakes; • Make adequate provision for safety of livestock during disaster and post-disaster periods; • Implement programs to encourage all citizens to plant trees in a planned manner in the coastal zone. Give emphasis to social forestry and other forms of plantations, plant care and maintenance; and • Improve the asset base of the poor with special focus on women through ownership or access to improve their coping capacity.

Water resource management	• Ensure adequate upland flow in water channels to preserve the coastal estuary eco-system threatened by the intrusion of soil salinity from the sea; • Build small water reservoirs to capture tidal water in order to enhance minor irrigation in coastal areas and establish the appropriate water management system within the polder utilizing existing infrastructure for freshwater storage and other water utilization; • Promote the rainwater harvesting and conservation; • Use ponds and tanks to conserve water and local technology for water treatment (such as ponds and filtering) for supply of safe water; and • Take the steps to ensure sustainable use and management of ground water.
Climate change measure	• Continue the existing institutional arrangements for monitoring of climate change in Bangladesh. Take steps to support upgrading of technology and institutional strengthening for enhancing their capacity for generation of better data and more accurate long-term prediction of the risks related to climate change; • Undertake implementation of adaptive measures identified in relation to climate change impacting the coastal zone and resources; • Make efforts to continuously maintain sea-dykes along the coastline as the first line of defence against predicted sea-level rise; and • Create an institutional framework for monitoring/detecting sea level rise and contingency plans for coping with its impact.

Source：CZPo (2005)

2.1.7 Coastal Development Strategy 2006

The "Coastal Development Strategy (CDS) 2006" is a set of development strategies for the coastal area of Bangladesh formulated by MOWR based on the approved Coastal Zone Policy (CZPo) 2005. In order to link between the CZPo and concrete interventions, CDS sets up nine strategic priorities: 1. ensuring fresh and safe water availability, 2. safety from man-made and natural hazards, 3. optimizing use of coastal lands, 4. promoting economic growth emphasizing non-farm rural employment, 5. sustainable management of natural resources: exploiting untapped and less explored opportunities, 6. improving livelihood conditions of the people (especially women), 7. environmental conservation, 8. empowerment through knowledge management, and 9. creating an enabling institutional environment. It also establishes objectives and activities based on these priories. Implementation of the CDS started from January 2006, with establishment and operationalization of the Program Coordination Unit (PCU).

The PCU was set up at the national (central) and local levels (city and district). The PCU at the national (central) level is composed of a steering committee of related ministries, a technical committee and focal point group and coordinates facilitators and ICZM processes. On the other hand, District Development Coordination Committees (DDCC) and Upazila Development Coordination Committees (UDCC) undertake a role in promoting local development and effective resource management at city and district levels, and NGO, civil society and other stakeholders follow this promotion as partners.

2.1.8 Bangladesh Climate Change Strategy and Action Plan 2008

The Bangladesh Climate Change Strategy and Action Plan (BCCSAP) was formulated in 2008 as the aftermath of the 13th Conference of Parties of United Nations Framework Convention on Climate Change (COP13) at Bali. BCCSAP introduces the action plan for programs corresponding to concrete needs with definite schedules, aiming at clear strategies for management of climate change and its impacts in Bangladesh. BCCSAP also notes the "Climate Change Action Plan" focused on six elements: 1. food security, social protection and health, 2. comprehensive disaster management, 3 infrastructure, 4. research and knowledge management, 5. mitigation and development of lower carbon emission, and 6. capacity building and institutional strengthening in order to eradicate poverty and achieve economic and social well-being through the vision of the Government of Bangladesh. The "Climate Change Action Plan" is a 10 year program (2009-2018) aiming at national recovery and capacity strengthening for climate change. The implemented activities under this plan are mainly targeted for the needs of the poor including children.

2.1.9 Strategic Program for Climate Resilience (SPCR)

The "Strategic Program for Climate Resilience (SPCR)" is based on the National Adaptation Program of Action (NAPA) formulated in 2005 (revised in 2009) in order to correspond to BCCSAO and COP7. SPCR is a strategic program formulated in 2010 to achieve the climate change resilience for the medium and long terms at the national level as well as forming the basis of an investment program for climate resilience in Bangladesh. Aimed at reformation of development policy for climate change measures considering the objectives such as poverty reduction and sustainable development in Bangladesh, the "Pilot Program for Climate Resilience (PPCR)" by the Strategic Climate Fund (SCF) was formulated under the Climate Investment Fund (CIF) with some donor support. PPCR is structured in two phases. Phase I imitates a series of tasks in each country, including facilitation of a cross-sector dialogue to arrive at a common vision of climate resilience in the medium and long terms, and formation of a strategic approach for climate resilience. Phase II focuses on implementing the SPCR through actions such as support to policy reform, institutional capacity building, and scaling-up other investments in key sectors.

2.2 Bangladesh's Implementation Systems in Terms of Disaster Management in the Coastal Areas

2.2.1 Bangladesh Water Development Board (BWDB)

Jurisdictional Coverage

The Bangladesh Water Development Board (BWDB) Act (2000) stipulates that the jurisdiction of BWDB is determined by the National Water Policy (NWPo) and NWMP (National Water Management Plan). Table 2-9 shows the details.

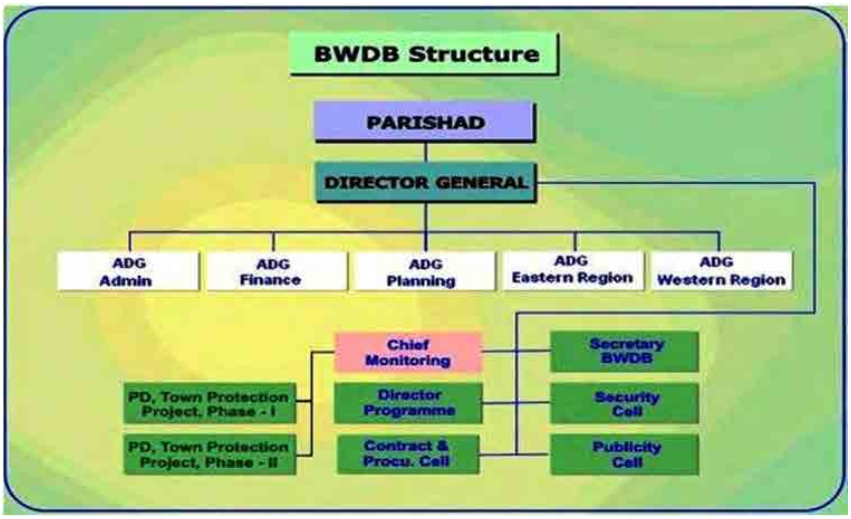
Table 2-9 The Jurisdiction of BWDB

Implementation of Structural Countermeasures	1	Rehabilitation of rivers, flood control, water discharge, construction of dams, floodgates, water reservoirs, dikes, and structures for water level and flow control for surface irrigation and drought prevention
	2	Removal of obstructions and excavation of deposits in order to promote the water flow and dividing flow for the purpose of support of fishery, river traffic, forest management, utilization of wild life and environmental improvement
	3	Project for soil management, land accretion, reclamation and outlet management.
	4	Rehabilitation of rivers and maintenance of river banks in order to prevent the inundation from encroaching on the city areas, markets, historically and public important areas
	5	Construction, operation and maintenance of sea embankments
	6	Prevention of seawater penetration and desertification
	7	Secure rain water for irrigation, environmental conservation, and drinking water supply
Implementation of Non-structural Countermeasures	8	Forecast and warning of flood and drought
	9	Hydrological investigations
	10	Construction of dike roads for the purpose of environmental conservation and improvement and poverty reduction, forestry and fishery development in the jurisdictional area of BWDB
	11	Organization of water recipients and stakeholders. Planning, implementation, operation and maintenance of the organizations. Participation and training on long-term and sustainable cost recovery by the beneficiaries of successful projects

Source: BWDB

Organization

BWDB has mainly 5 wings under the Director General (DG); the Administration Wing, Finance Wing, Planning Wing, Operation and Maintenance Wing of the Eastern Region, and Operation and Maintenance Wing of the Western Region. One Additional Director General holds jurisdiction over each wing and assists the DG. Each wing has several divisions under it. Operation and Maintenance Wings of both the Eastern and Western regions have jurisdiction over regional offices. Their coverage is divided into the eastern and western parts at Brahmaputra (Jamuna) river.



Source: BWDB website

Figure 2-1 Organization Chart of BWDB

The Number of Officers

BWDB has reformed its organization since the 1990's. It is reported that the number of BWDB officers was 8,935 in 1998. However, current BWDB consists of 6,436 officers as of April, 2012.

Activities after Cyclones "SIDR" and "AILA"

BWDB decided to take 3 steps as countermeasures against the damage by cyclones after they established a countermeasure committee in order to investigate the damage; these include "Emergency countermeasures" as the first countermeasures which fulfil the basic needs, "Urgent recovery countermeasures" as the second countermeasures which promote the rehabilitation to the original state and "Full-fledged improvement projects" as the third countermeasures which develop the future condition.

The emergency countermeasures have a budget of 4.1 hundred million yen and 25,000 MT of Food Grain for emergent closure of the broken dikes, construction of marginal dikes, urgent repair of drainage gates *etc*.

From 2009 to 2010, the urgent recovery countermeasures have been conducted by utilizing the GoB budget (DPP, NDR) and aid from foreign countries. A total of BDT 1.0 billion has been secured from BWDB budget for operation and maintenance and has been divided into BDT 7.4 hundred million for the polders of 3 districts in the south western region and BDT 2.6 hundred million for the polders in Barisal to start the urgent recovery countermeasures. As foreign financial aid, the two organizations (WB and ADB) with 3 major projects have committed. The total amount of the aid is USD 25.2 million. The breakdown is as follows.

WMIP	=USD	9.59 million
ECRRP	=USD	8.00 million
SWAIWMP(EDDRP)	=USD	7.61 million
Total	=USD	25.2 million

As for the full-fledged improvement projects, approximately 5 years is assumed as the implementation period. It is expected to obtain the technical and financial support from foreign countries. This project covers not only the rehabilitation of polder facilities but also improvement of watershed security concerning the seawater level increase due to global warming, improvement of dike compaction methods, stop of soil spill by erosion protection methods, planting mangrove forests around polders, drainage rehabilitation in the polders and construction of new drainage gates. The project has requested foreign aid from the World Bank, Japan and the Netherlands.

Table 2-10 Foreign Aid to 3 Affected Polders of 3 Districts in South Western Region1

Districts	BWDB O&M Division	Polder	Foreign Financial Aid（Lakh Taka）			
			WMIP	ECRRP	SWAIWMP (EDDRP)	Total
Satkhira	O&M Division 1	5	-	-	1,521.17	1,521.17
		15	-	-	740.00	740.00
	O&M Division 2	6-8&6-8Ext	47.13	-	-	47.13
		7/1	1,077.54	-	-	1,077.54
		7/2	73.42	-	-	73.42
		13-14/2	2,484.97	-	-	2,484.97
		14/1	892.72	-	-	892.72
Khulna	O&M Division 1[2]	-	-	-	-	-
	O&M Division 2	31	-	-	835.73	835.73
		32	-	-	1,400.20	1,400.20
Bagerhat	O&M Division	35/1	3,195.68	-	-	3,195.68
		36/1	706.08	-	-	706.08
Total			8,477.54	-	4,497.10	12,974.64

Note: 1. The above amounts show the total budget for 4 years (2009/10, 2010/11, 2011/12, 2012/13). Budget for 2012/2013 includes the estimated amount. 2. Foreign aid to Khulna O&M Division 1 is unconfirmed.
Source: BWDB O&M Divisions (Satkhira, Khulna, Bagerhat)

The JICA Survey Team had visited frequently district level offices of BWDB (Khulna-2, Satkhira-1, Satkhira-2 and Bagerhat) and discussed through the interview survey including field survey. The profiles of the BWDB offices are described below based on the interviews during the survey in Bangladesh.

Activities of district level offices of BWDB (Khulna-2, Satkhira-1, Satkhira-2 and Bagerhat)

The main tasks of the BWDB offices are the followings:

- Plan and implementation of the given mandates of BWDB (1. Flood Control, 2. Drainage, 3. Irrigation, 4. Land reclamation and 5. Town protection) including environmental impact assessment and people's active participation
- Redesigning and strengthening of the water/disaster management interventions in accordance with people's needs.
- Implementation of NWP
- To visit the disaster-affected areas and to act accordingly, such as, rehabilitation/repair of embankments/sluice gate, construction of closures, bank protection works, *etc*.

Issues

The issues, which were obtained based on the comments from the BWDB offices, are the followings:

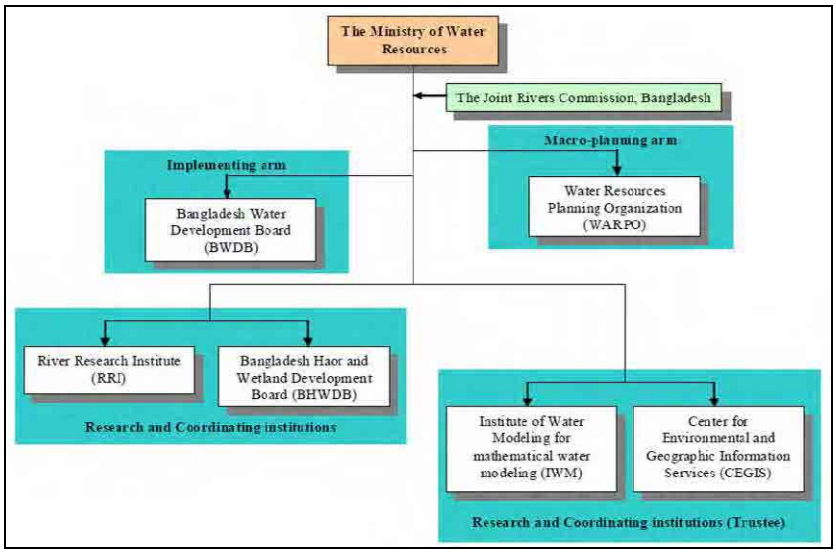
- Upgrading of existing embankments (crest level, cross-section)
- Bank Protection works (CC blocks, mechanical compaction, possible study/research on salt tolerant vegetation)
- Strengthening of Water Management Groups
- Re-excavation of drainage canals
- Construction & implementation at Polder 35/2
- The existing polders were constructed in the years between 1960 and 1970. In 40 years or more, lots of structures are not functional.
- Sustainable development involving project beneficiaries
- Difficulty in proper activities especially for field trips and operation & maintenance due to insufficient number of staff and budget

2.2.2 Ministry of Water Resources (MoWR)

The Ministry of Water Resources (MoWR) is the highest national authority in water resources development and management, providing planning, regulations, standards and guidelines related to water resources development and management.

The mission of the MoWR is to develop the socio-economic conditions of the people of the country and protection of their lives and properties through harnessing, efficient utilization, management, preparation of time appropriate water use policy and its implementation and ensuring sustainable development of water resources by using information and environment friendly technologies.

Under the MoWR, major organizations include; WARPO, BWDB, River Research Institute (RRI), IWM, and CEGIS. Also DPHE, LGED, Water and Sewage Authority, Department of Fisheries, BIWTA, Road & Highway Department, and Department of Environment are providing water resources management/development work.



Source: MoWR Country paper

Figure 2-2 Hierarchy of Water Resources Management in Bangladesh

2.2.3 Disaster Management Bureau (DMB)

Overview of the Organization

The Disaster Management Bureau (DMB) is a technical arm of Disaster Management & Relief Division, MoFDM. And, DMB is meant to overview and coordinate all activities related to disaster management from national to the grass-root level. Bangladesh lost a number of people's lives and suffered from serious economic damage by the flood in 1988 and the cyclone in 1991. After the damage, the necessity of preliminary countermeasures for damage minimization was considered. DMB was established from this point of view, as a small expert unit consisting of approximately 40 officers. It takes a comprehensive and managerial role on disaster management from national to grass-root levels and enables cooperation among relevant organizations.

Responsibility

DMB plays important roles in the disaster management sector, operation and maintenance of any information related to disasters, and listing of technicians. It also conducts awareness programs, formulation of regional disaster management action plans, monitoring of disaster prevention activities, coordination among related agencies, NGO and other organizations.

Its wide coverage is as mentioned below:

- Dispatch of experts to NDMC and IMDMCC
- Promotion of disaster deterrence, mitigation and prevention activities to all governmental agencies
- Promotion of establishment of related guidelines, implementation of training activities, and formulation of disaster countermeasures action plan
- Sustainable coordination with related agencies, NGO and other organizations

Activities

DMB has identified disaster risk factors, promoted damage mitigation activities in District, Upazila and Union levels, installed disaster management policy in the community level and unified disaster response processes, *etc*.

In addition, after receiving early warning transferred from BMD, DMB transfers the cyclone early warning to regional governmental agencies (District, Upazila and Union).

Issues

The Survey reveals that the Union broadcast the cyclone information by utilizing microphones when AILA occurred and the early warning reached the local people. However, early warning transfer through disaster management committees of the Union has not been conducted in most regions.[1] The disaster management activities other than information transfer by the Union disaster management committee have not been recognized by local people either and require to be improved (*e.g.* activation of the committee, enhancement of committee activities).

2.2.4 Bangladesh Meteorological Department (BMD)

Responsibility

The Bangladesh Meteorological Department (BMD) has jurisdiction over weather observation and forecasting in Bangladesh. BMD implements surface weather observations, observation by

[1] In fact, when the earthquake occurred near the north western Sumatra coast on 11th April 2012 (local time in Indonesia, 15:38), Polder No. 5 (Satkhira district) reported that the early warning issued by BMD reached Union level and the Union alerted people to evacuate. As an information transfer tool, loud speakers in mosques are usually utilized.

weather radar system, observation by pilot balloons, observation by radiowomen *etc*. In addition, BMD cooperate with India and other foreign countries and implements the weather forecast utilizing the data from such cooperative organizations. The Storm Warning Centre (SWC) under the jurisdiction of BMD has responsibility for announcement of cyclone early warnings.

Activities[2]

In Bangladesh, the warning system was installed with support from various donors including Japan in order to mitigate damage caused by floods and cyclones in the 1970's. SWC of BMD takes a role of weather analysis for cyclone warning. It conducts the forecasting activities by gathering the observation data 8 times per day from 35 observing stations including 5 weather radars in the country and weather and water level data from India. All data is transferred to SWC in Dhaka by the telecommunicating system and analyzed. Cyclone warnings are issued by BMD after weather analysis by SWC and transferred to other agencies in the following order: DMB, Divisional disaster management committee, Upazila disaster management committee, Union disaster management committee and local people.

BMD's Response to Cyclone"AILA"

Cyclone "AILA" was originally a tropical depression that occurred near Bengal coast located in the southern part of Bangladesh on 20th May 2009. The tropical depression consistently moved to the north and increased its speed before landing on the western part of the Bengal coast. It then became a large cyclone and landed on Bangladesh at 13:30 to 14:30 of the 25th of May.

The following comments are the results of interview survey on the response by BMD to cyclone "AILA" on the 25th of May 2009.

- BMD analyzed the situation of the tropical depression moving north by collecting the information from India Meteorological Department (IMD) before it became a cyclone.
- The south western part of Bangladesh where cyclone "AILA" hit had not experienced a cyclone previously. IMD forecast that the tropical depression would not become a cyclone. BMD also followed IMD's forecast.
- However, the tropical depression's speed moving north increased rapidly and the low pressure enlarged drastically. This situation created a cyclone. This phenomenon was beyond IMD's and BMD's scope of assumption.
- Immediately before the cyclone's landing, BMD issued the highest-level warning and transferred it to the Union level. However, it is not clear that the warning was transferred from Union to local people immediately. As a result, they lost the proper timing.
- Cyclones had not hit the south western regions in the past. However, recent cyclones such as ""SIDR" in 2007 and "AILA" in 2009 hit the southern and south western regions. It is necessary to enhance the early warning transfer in those regions.

Issues

BMD takes its responsibility for warning transfer only until the warning issuance through SWC. How warnings are transferred to the community level after issuance is out of their scope. Therefore they cannot ensure the warning they issued really reach the people.

[2] This paragraph is partly based on Japan Telecommunications Engineering and Consulting Service (2007).

2.2.5 Local Government Engineering Department (LGED)

Local Government Engineering Department (LGED) is one of the largest public sector organizations in Bangladesh entrusted for planning and implementation of local level rural urban and small scale water resources infrastructure development programs. LGED works closely with the local stakeholders to ensure people's participation and bottom–up planning in all stages of project implementation cycle. The broad objectives of LGED's development activities are to improve the socio-economic condition of the country through supply of infrastructures at local level and capacity building of the stakeholders. LGED works in a wide range of diversified programs like construction of roads, bridges/ culverts and markets to social mobilization, empowerment and environmental protection.

LGED is highly decentralized organization where ninety nine percent of total manpower works at District and Upazila (Sub-District) level. The profiles of the district offices of LGED are described below based on the interviews during the survey in Bangladesh.

Activities of district offices of LGED (Khulna, Satkhira and Bagerhat)

LGED district office is supposed to implement the projects such as planning/construction of growth centre, rural market, complex building of union parishad, server station for database, hydraulic structures for irrigation purposes, roads & bridges, primary school development including cyclone shelters. In the water sector, LGED can implement the works for small scale (below 1,000 ha) including sub-polders. Water Management Cooperative Association (WMCA) is an example of working with the community.

Issues

The issues, which were obtained based on the comments from the LGED district offices, are the followings:

- The infrastructure (*e.g.* road, facility, market, cyclone shelter, *etc*.) is still insufficient, thus more development is necessary.
- Such infrastructure is need to be strengthened against natural disasters as well as future climate change effects.
- Drinking water has been seriously affected by salt damages.

2.2.6 Center for Environmental and Geographic Information Services (CEGIS)

CEGIS aims at supporting the management of natural resources for sustainable socio-economic development using integrated environmental analysis as a scientifically independent center of excellence. CEGIS has been carrying out integrated environmental analysis by using modern technologies such as a geographic information system (GIS), remote sensing (RS), databases and information technology (IT) and others. It provides solutions to issues and problems in various sectors like water, land, agriculture, fisheries, the environment, engineering, power, energy, transportation, *etc*., and recommends technical options based on local realities that are feasible from the socio-economic and institutional point of view.

2.2.7 Institute of Water Modeling (IWM)

The Institute of Water Modeling (IWM) provides highly technical services in the field of Water Modeling, Computational Hydraulics & Allied Sciences for improved integrated Water Resources Management. The applications of IWM modeling tools cover a wide range of water related areas such as: flood control, flood forecasting, irrigation and drainage, river morphology, salinity and sediment transport, coastal hydraulics, port, coast and estuary management, environmental impact assessment, bridge hydraulics and related infrastructure. IWM also has the state-of-the-art techniques and equipment for river surveys in large rivers in developing the

models and has developed a very comprehensive database covering almost the entire country for a long period.

2.2.8 Department of Public Health Engineering (DPHE)

The Department of Public Health Engineering (DPHE) is the national lead agency for provision of drinking water supply and waste management in the country[3]. With the challenge generated by the discovery of arsenic in incremental areas since its first detection in 1993, DPHE with its development partners is trying to ameliorate the water related issues. Further, DPHE is implementing various projects for solid waste and sewage water management in order to conserve the environment.

Planning, construction, and improvement of water supply development projects or rural water supply facilities are implemented by the DPHE. After completion, the facilities are handed over to Caretakers[4].

2.2.9 Ministry of Health & Family Welfare (MoHFW)

The Ministry of Health & Family Welfare (MoHFW) seeks to create conditions whereby the people have the opportunity to reach and maintain the highest attainable level of health, by providing medical services.

The MoHFW is responsible for providing curative and preventive health services to the people during disaster. The Ministry also keeps a vigilant eye out for ensuring health care to the affected areas soon after disaster by sending medical teams on an emergency basis.

2.2.10 Ministry of Environment & Forest (MoE&F)

The Ministry of Environment & Forests (MoE&F) has a special role to play in disaster management and climate change risk reduction, especially in normal periods and during the rehabilitation stage, because disaster can happen due to deterioration of the environment. Forestation may be able to contribute in a large way to decrease the risk of disasters such as cyclone, floods, droughts, *etc*.

2.2.11 Three District Offices in Southwest Area (Khulna, Satkhira and Bagerhat)

Each District Office has a Disaster Relief & Rehabilitation Office (DRRO), who works under the MoFDM. In accordance with the Comprehensive Disaster Management Program (CDMP) and the SOD, the Deputy Commissioner acts as the superior Executive Officer of the District under his administrative control in respect of all activities related to disaster preparedness, response, relief and rehabilitation at all phases, that includes; pre-disaster (prevention), during disaster (response and rehabilitation), and after-disaster (reconstruction). Also, with assistance from the Disaster Management Bureau, the DC Office conducts orientation courses for all Upazila level officers and staff in cyclone/flood prone areas on disaster and training programs in order to prepare for cyclones/floods. At the time of disaster, the DC offices provide disaster information to the district populations in cooperation with the Upazila Head quarters. Right after the Cyclone "AILA", the office prepared a list of damages based on the information provided by the Upazilas.

[3] Excludes major cities where WASA (Water and Sewerage Authority) are established such as Dhaka, Chittagong, Khulna, etc.

[4] During the Survey, based on the interview, it was pointed out that Water User Community collects water fees or provides monitoring activity. The details of "Water User Community" and "Caretakers" have not been confirmed.

3. Current Status of International Aid Agencies and NGOs

3.1 International Aid Agencies

3.1.1 Asian Development Bank (ADB)

ADB, like the World Bank Groups, is one of the major international donor organizations, providing various support in the fields of water resources/disaster controls. Main frameworks include; "Strategy 2020 (Three Strategic Goals: 1) Integrated Economic Growth, 2) Sustainable Development considering the Environment, and 3) Regional Integration)" and "Water for All (support for Water Policy by promoting Social Investment)".

For Bangladesh, ADB focuses their support on the following four fields; 1) Integrated Water Resources Management (IWRM), 2) Disaster Risk Management (DRM), 3) Water Policy, and 4) Organizational Reforms and Capacity Strengthening. As of now, ADB has implemented 27 loan projects (approximately USD 1,010 million in total) in the water resources management sector. Currently ADB has the following four (4) on-going loan projects (approximately USD 195 million); 1) Jamuna-Meghna River Erosion Mitigation Project, 2) Secondary Towns Integrated Flood Protection, 3) Southwest Areas Integrated Water Resources Management, and 4) Participatory Small-Scale Water Resources Sector Project.

In Bangladesh, donor meetings called "Local Consultative Groups (LCG)" are established by sectors. The Dutch government plays an important role as a chairman for coordination of the Water Management Working Group. ADB, together with the Dutch government, has played a role as a Chair of the Water Resources Management, promoting cooperation among the donors through the LCG meetings.

Below, ADB's recent significant approaches of Southwest Area Integrated Water Resources Planning and Management Project (SAIWRPMP) are explained.

South-West Area Integrated Water Resources Planning and Management Projects (SAIWRPMP)

This project focuses on existing FCDI with low productivity in Jessore and Narail, consisting of formulation of integrated water resources management by community participation, formation of sustainable water management systems (including rehabilitation of infrastructure), and institutional/organizational strengthening. At the national level, this project implements strengthening of WARPO, and improvement of BWDB's capacity on operation and management. At community level, the project facilitates sustainable operation and management by community participation. Additional rehabilitation projects are implemented at Polder 5, 15, 31, 32 in the areas affected by Cyclone "AILA". Total project cost is USD 20 million (ADB only) and project implementation period is from August 2006 (loan effective) to 2012-13.

3.1.2 Food and Agricultural Organization of the United Nations (FAO)

FAO is a UN agency dealing with anything related to food security. In the southwest coastal zone of Bangladesh, FAO has implemented various supports, including providing emergency relief and formulating livelihood since right after the Cyclone "SIDR". FAO focuses on a comprehensive approach in cooperation with the Ministry of Agriculture. FAO was also proactive in implementing ECRRP lead by World Bank, by inputting a budget of USD 10 million. ECRRP is divided into Component A to F. FAO implemented their activities in the Component A: Recovery of Agriculture Sector and Improvement Program.

Following are the recent approaches taken by FAO:

- Formulation of comprehensive Master Plan for the southwest coastal zones

- Framework of Food Security Cluster (FSC)
- Dealing with prolonged flooding in the southwest areas

3.1.3 The Netherlands

The Netherlands is one of the major donors in the water related sectors for Bangladesh. Their focus in assistances has been shifted from rehabilitation of infrastructures such as construction of embankment/polders and river dredging to management of related assistance such as technological support and organizational strengthening. At the end of 2011, the Netherlands formulated the Multi Annual Strategic Plan (MASP 2012-2015), emphasizing 1) Water Management, 2) Food Security, 3) Gender Education, and the Water Management is considered as the most important strategy among them all. The Water, Sanitation and Hygiene (WASH) programme aims to initiate an holistic approach incorporating hygiene promotion and education to 30 million people (25 M under WASH-I and an additional 5 M under WASH-II), across the country through the largest NGO, BRAC. Total amount of the grant is EUR 30-40 million.

The Integrated Planning for Sustainable Water Management (IPSWAM) programme aims to assist the BWDB to implement sustainable integrated water resources management with public participation at the 9 polders in the coastal zones.

The next version of IPSWAM is called the Blue Gold program, aiming at a more integrated approach by joining other organizations (*e.g.* DAE) and including other needs (*e.g.* Food Security).

In addition, the Netherlands is preparing the formulation of the "Bangladesh Delta Plan", considering the impacts of climate change for the next 50 and 100 years, and the Plan will be implemented in the next 2 to 5 years.

The following explains the Embassy's recent approaches; 1) IPSWAM Program, 2) Blue Gold Program, and 3) Bangladesh Delta Plan.

(1) Integrated Planning for Sustainable Water Management (IPSWAM) Program

The IPSWAM Program has been implemented for the 5 years since November 2003, targeting at 9 polders located in the south or southwest coastal zones. Main focus was to promote community participation for the efficient management and appropriate utilization of water resources. Total amount of the program is BDT 870.6 million, with BDT 618.1 million from the Netherlands and BDT 252.5 million from the GoB.

Main objectives of the program are;

- Ensure community participation in all phases (selection, plan, implementation, operation and maintenance, monitoring and evaluation) for water facility rehabilitation work
- Implement sustainable water management by active community participation, and strengthen knowledge and capacity of planning, implementation, and management
- Through the water management group established democratically, hand over the management responsibility (some or all) from BWDB to the community

This program organizes water management groups for community participation.

(2) Blue Gold Programme

Currently, the Netherlands is preparing the "Blue Gold Programme", as a continuation of IPSWAM. The implementation period is 7 years. The project components include; 1) water management, 2) food security, 3) water and sanitation.

Target areas of the "Blue Gold Programme" will be 24 polders in 6 districts (Barguna, Barisal, Jhalokati, Patuakhali, Pirojpur, and Khulna) of the coastal zones. A total of 24 polders have been selected but not finalized yet.

Table 3-1 Nominated Polders for Blue Gold Programme

Polder		Area	Polder		Area
1	Polder 2	South West	13	Polder 28/2	South West
2	Polder 4	South West	14	Polder 31	South West
3	Polder 6-8	South West	15	Polder 31/part	South West
4	Polder 7/1	South West	16	Polder 34/1	South West
5	Polder 7/2	South West	17	Polder 41/2	South
6	Polder 9	South West	18	Polder 47/3	South
7	Polder 19	South West	19	Polder 54	South
8	Polder 20	South West	20	Polder 55/2D	South
9	Polder 21	South West	21	Polder 55/2E	South
10	Polder 26	South West	22	Satla Bagda Project Polder No 1	South
11	Polder 27/1	South West	23	Satla Bagda Project Polder No 2	South
12	Polder 28/1	South West	24	Raghunathpur	South

Source: Programme Formulation Report, Blue Gold Programme (March 2012)

(3) Bangladesh Delta Plan

The Netherlands will prepare the "Bangladesh Delta Plan", in cooperation with the GoB, and taking into account the impact of climate change for the next 50 to 100 years. The program will be formulated in the next 2 to 5 years. GoB plans to take an integrated approach with a cross-functional team within the Ministries by appointing the Planning Commission as an implementing agent.

The Vision of the development for delta areas of Bangladesh is to achieve long-term sustainable development through water policy based on the scenario analysis, integrated policy, and integration of appropriate organizational institutions and capacity. The Vision of the "Bangladesh Delta Plan" can be achieved by implementing the integrated strategy and plans for 50 to 100 years. The "Bangladesh Delta Plan" will formulate the ground design for clearer vision towards year 2100. Based on the vision, it is possible to take actions for the prospective future.

3.1.4 United Nations Development Programme (UNDP)

The United Nations Development Programme (UNDP) has basic policy on support of Bangladesh to reduce the nation's risk and vulnerability to a variety of human-induced and natural hazards.

There are two support projects by UNDP, the Comprehensive Disaster Management Programme (CDMP) and the Early Recovery Facility (ERF) which have been implemented complementally. CDMP focuses on risk reduction, professional training and capacity strengthening, while ERF addresses preparation and response after disaster.

(1) Comprehensive Disaster Management Programme (CDMP)

There are two phases of CDMP-I and CDMP-II. CDMP-I was implemented from 2004 to 2009, while CDMP-II has been implemented from 2010 and will run to 2014. The primary partner in Bangladesh is the Ministry of Food and Disaster Management (MOFDM), and donors are

UNDP, DFID, EU, Norway, Sida, and the Australian Agency for International Development (AusAID) with expected total budget USD 69.47 million.

There are the following seven activities in CDMP-II

- Support for Disaster Management Committees (DMCs) at each local government level (Union, Upazila, District)
- Policy support for 12 main related ministries.
- Expansion of livelihood
- Capacity enhancement for farmers
- Training for volunteers regarding earthquake countermeasures in cities
- Evaluation of earthquake risk
- Work implementation for risk reduction in cities

(2) Early Recovery Facility (ERF)

The "Early Recovery Facility (ERF)" has been implemented from 2011 and will run to 2015 by GoB, UNDP, and other NGOs as implementing partners. With the budget of USD 5.86 million, activities include living improvement and a shelter program from the long-term point of view. ERF's primary aim is to generate self-sustaining, nationally owned, resilient processes for recovery.

(3) Disaster Resilient Habitat

This project (Disaster Resilient Habitat) is a pilot project as a part of its research and development of the ERF. Besides the activities of ERF mentioned above, UNDP supported construction of 43 disaster resilient houses, which was implemented in cooperation with BRAC University. Community participation was essential to construct the shelters, and after much discussion, models that would be stronger and safer in the high winds of a cyclone were completed.

3.1.5 World Bank (WB)

WB is the major donor organization in the water sector for Bangladesh. The recent approaches by the WB are; 1) Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP), 2) Coastal Embankment Improvement Project (CEIP), and Water Management Improvement Project (WMIP).

(1) Emergency Cyclone Recovery and Restoration Project (ECRRP)

The main objective of the ECRRP is to formulate a long-term disaster control/management system by rehabilitation and reconstruction of infrastructures and livelihood damaged by the Cyclone "SIDR". Planned implementation period is 6 years from November 2008 to June 2014, with the estimated budget of USD 221 million. The target area is the whole coastal zone of Bangladesh.

Source: ECRRP, World Bank

Figure 3-1 ECRRP Target Areas

Table 3-2 Components of ECRRP

Component		Description
A	Recovery of Agriculture Sector and Improvement Program	Provide agriculture (crop, livestock and fishery) recovery assistance, and introduce sustainable improvements to agricultural practices. A1: Support to the crops sub-sector A2: Support to the fisheries sub-sector A3: Support to the livestock sub-sector A4: Support to community mobilization and facilitation and component management
B	Reconstruction and Improvement of Multipurpose Shelters	Provide greater protection for the vulnerable population and livestock in the cyclone prone areas B1: Construction of new shelters（100 locations） B2: Improvement of existing shelters（350 locations） B3: Improvement of communication network to shelters（roads, telecommunication） B4: Design and construction supervision of shelters
C	Rehabilitation of Coastal Embankments	Prevention of saline inundation in the normal times, maintain high crop production, mitigate impacts from cyclones C1: Rehabilitation of Coastal Embankments C2: Design and construction supervision of coastal embankments
D	Long-Term Disaster Risk Management Program	Strengthen disaster risk mitigation and reduction capacity and ability of the Government for medium-long terms D1: Preparation of future projects for River Bank Improvement and Coastal Embankment Improvement Programs D2: Preparation of future projects for River Bank Improvement (BRE) and Embankment Improvement Project (CEIP) D3: Preparation of future construction projects for cyclone shelters and upgrading of rural road network
E	Monitoring and Evaluation of Project Impact	Assist PSC/PCMU in monitoring and evaluation of the ECRRP as a whole and its components

Component		Description
F	Project Management	Support the Government in implementing the Project, coordinating all project related activities, and provide resources for required strategic studies, and provide technical assistance and training. F1: Project Management F2: Consulting services for post disaster F3: Strategic studies regarding insurance F4: Technical assistance and training for disaster controls F5: Emergency support for future disasters

Source: ECRRP, World Bank

(2) Coastal Embankment Improvement Project (CEIP)

The Coastal Embankment Improvement Project (CEIP) is one of the components of ECRRP, focusing on increasing the resilience to natural disasters and climate change for the coastal population by improving the embankment and improving the safety.

- Reduce the loss of lives, assets, crops, and livelihood
- Reduce the time of recovery from natural disasters
- Mitigate salinity intrusion which is anticipated to become worse due to climate change

The program aims at increasing the crop production by improving the polder systems.

The CEIP is divided into two (2) categories.

Assignment A): A detailed Feasibility Study according to international standards, which forms the basis for project appraisal by the World Bank and the Government of Bangladesh at the end of the First Assignment which also covers Detailed Design of the first batch of works

Assignment B): Continuation of the Detailed Design and supervision of the CEIP-I works as the Second Assignment that would be implemented through international contracting practices

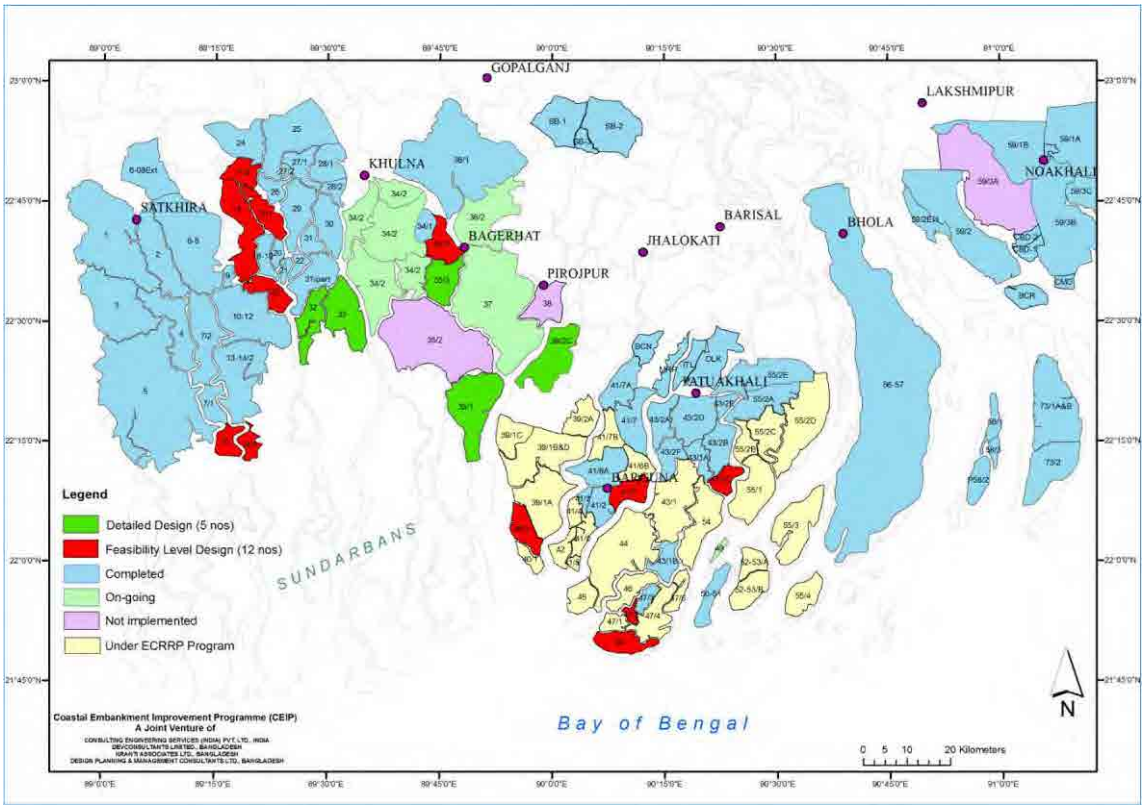
Total cost for improvement/rehabilitation of polder systems in the coastal zones is estimated to be up to USD 375 million (June 2012).

In the Assignment A, 17 polders were selected for F/S and D/D. The polders were selected based on Multi-criteria analysis, as well as other factors such as clustering of polders within each phase, avoiding those already being rehabilitated. Some political circumstances are also incorporated. The table below shows the selected polders.

Table 3-3 List of Polders selected for CEIP

Selected 5 polders for D/D	Selected 12 polders for F/S
『32』, 『33』, 『35/1』, 『35/3』, 『39/2C』	『14/1』, 『15』, 『16』, 『17/1』, 『17/2』, 『23』, 『34/3』, 『40/2』, 『41/1』, 『43/2』, 『47/2』, 『48』

Source: CEIP, World Bank



Source: CEIP, World Bank

Figure 3-2 Selected Polders by CEIP

The crest level will be raised to meet the requirements to withstand the increase in storm surge levels from the 25 year return period level, considering the impact of climate change (Sea level rise of 0.5 m and 10% increase in maximum wind speed of cyclone). In addition, impacts from tidal surge and wind speed are analyzed in detail using simulation models. At this moment, the crest level shall be raised from the existing 3.0 to 4.0 m above sea level to 5.0 to 6.0 m above sea level (PWD standard).

(3) Water Management Improvement Project (WMIP)

Project Description

WMIP aims at strengthening of Operation & Maintenance of the facilities constructed by BWDB in the Participatory Scheme. It also aims at improvement of water resources management including the institutional development by strengthening of performance of Bangladesh's main water management organizations (BWDB and WARPO).

- Implementation Period: 18 Sept 2007 to 30 June 2015
- Budget: USD 123.26 million

Budget

The World Bank and the Dutch government provide funds and technical support, and total amount of the project budget is BDT 9,830 million. Within the budget, BDT 4,770 million is allocated to the rehabilitation component, which includes the facility rehabilitation in the AILA affected area, southwest coastal zones. The rest, BDT 5,060 million, will be allocated to the organizational development component.

Target Areas

The project target area is at the whole of Bangladesh; however, due to the financial constraints, priority areas shall be selected, and pilot projects will be implemented. A Participatory Scheme will be introduced in a wide range of phases from planning, design, and operation/maintenance, and after completion, all the projects will be handed over to the communities.

Community Participation Group

A Water Management Group (WMG) will be established at every village considering the water resource facility/catchment as a minimum unit of organization for promoting community participation. The WMGs from each village form a Water Management Association (WMA). Both the WMG and WMA are called Water Management Organizations (WMO).

WMIP has considered collecting water fees or irrigation fees from the beneficiaries through WMO, WMA, and WMG without imposing a tax. The collected fees will be saved in a bank account which is managed by the community, and it will be used in case of urgency or repair works of the water facilities.

3.2 NGOs

3.2.1 Bangladesh Red Crescent Society (BDRCS)

(1) Organization

BDRCS: Bangladesh Red Crescent Society has been implementing activities to extend cyclone warnings to the community-level through the Cyclone Preparedness Program (CPP).

(2) CPP's Actions

The CPP head office in Dhaka frequently shares cyclone related information with SWC. Once the warning is issued, the office distributes the information to Zonal and Upazila offices in coastal areas by its own HF radio network. Those offices provide the information to Union offices (the subordinate offices in their areas) which transmit the information to units under the Unions. Each office uses flag signals, announcements with loudspeakers, and VHF radios to spread the information. At the most basic level, volunteers with sirens and megaphones in their hands visit villages to tell inhabitants that there's a cyclone coming.

(3) CPP's Response to the Cyclone AILA

CPP actually does not cover most of the southwest areas (Khulna District, Satkhira District, and Bagerhat District) since almost no cyclones had hit the areas in the known history. Therefore, CPP implemented no functional activities even in the time of AILA. Learning from this experience, CPP is now working to establish their offices in the three southwest districts.

3.2.2 Bangladesh Disaster Preparedness Center (BDPC)

(1) Organization

The Bangladesh Disaster Preparedness Centre (BDPC) is an NGO established in 1993 which has comprehensively been covering all the Disaster Risk Reduction (DRR) issues. Its focus is especially on DRR by community empowerment and it works between poverty groups and local governments (Union and Upazila level) to facilitate their communications.

(2) Challenges of Community-based Disaster Risk Reduction

The survey team made interview with BDPC representative about DRR at the community-level. Their opinions are as follows:

- Most projects for disaster management in Bangladesh have been conducted with a top-down decision making process with almost no chance for the communities to become involved. The assistances from International Organizations reach only to Union and Upazila levels, but not to the population in the bottom.
- It is important to create a system which enables inhabitants to have an ownership of a cyclone shelter by promoting their participation even from the planning stage of its establishment. Collecting small amounts of money (such as 5 Taka) for participation might grow ownership which will motivate the community to work for its Operation and Maintenance under their own responsibility.
- SDC established 12 cyclone shelters taking into account local residents' opinions. BDPC learned the needs of the communities by staying together in a same house with them for continual and direct communication. Some shelters function as markets or clinics so they can come up with the money for their operation and maintenance.

3.2.3 Disaster Forum

The Disaster Forum is a networking organization for disaster management. Since its establishment by 25 participating groups in 1994, the forum has been working to promote people's rights and capacity development of (mainly to increase accountability of) humanitarian or development organizations. It consists of 70 participating groups (humanitarian groups, development organizations, research institutes, government ministries and individuals) today. The main purpose of the forum is to develop capacity of the community and reduce their vulnerability to disasters by improving the living situation and social structure in Bangladesh through their research and analysis. Their main capital sources are their fairs, seminars, trainings and publication of reports.

3.2.4 BRAC

(1) Organization

BRAC, based in Bangladesh, is the world's largest non-governmental development organization. Established in 1972, BRAC is present in all 64 districts of Bangladesh, with over 7 million microfinance group members, and 91,000 health volunteers. In 2011, BRAC was the largest NGO by number of staff employing over 90,000 (of which 60% are women).

The organization is 80% self-funded through a number of commercial enterprises that include a dairy and food project and a chain of retail handicraft stores called "Aarong". BRAC's budget for the activities in Bangladesh in 2011 was USD 572 million, of which 24% was from donor agencies.

In the Disaster Prevention sector, in cooperation with the other international agencies, BRAC provides information such as Daily Situation Reports and weather forecasts, in order to support the food security and economic rehabilitation of the victims.

Major international donors include AusAID, DFID, the Netherlands, the European Union (EU), Canada, United Nations Children's Fund (UNICEF), and other various ministries and departments of the GoB and local/international NGOs.

(2) Activities

BRAC has been quick to respond to natural disasters, reaching out with emergency relief and rehabilitation support. In order to respond proactively to the increasing frequency and severity of natural disasters as well as impacts of climate change, BRAC's Disaster, Environment and Climate Change (DECC) program is moving beyond relief and rehabilitation into institutionalized preparedness, risk reduction and management interventions as well as long

term adaptation strategies. The DECC's objectives include; 1) to enhance BRAC's institutional capacity to proactively respond to natural disasters, 2) to build capacity at the community level to face natural disasters due to climate change, 3) to establish predictive research capacity within BRAC, 4) to facilitate information transfer and education of government policies and aid, and 5) to respond to natural disasters in Bangladesh and other countries.

3.2.5 Shapla Neer: Citizens' Committee in Japan for Overseas Support

(1) Organization

Shapla Neer is a Japanese non-governmental organization established in 1972 that provides emergency relief and social services to underprivileged communities in Bangladesh and Nepal. Main activities include; support for street children, support for female domestic workers, and community development to reduce disaster damages.

(2) Activities

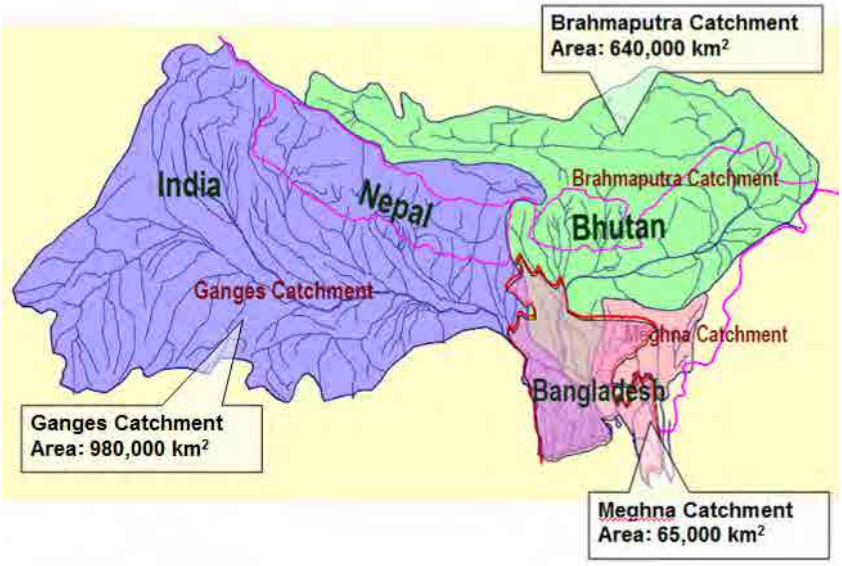
Shapla Neer implements disaster prevention activities by strengthening partnership with local governments and other NGOs. The disaster prevention activities focus on local youth, who will be the next generation of adults, to become responsible for reducing disaster damage in the villages. Shapla Neer also provides emergency relief and rescue, and recovery assistance, by providing support for improvement of the livelihood of the victims, collecting information in the affected areas, and sharing information among the stakeholders.

4. Cyclone Damage in the Southwest Coastal Area

4.1 Basic Information of Three Districts in Southwest Coastal Area

4.1.1 Natural Condition

Bangladesh is located at the lower catchment of three (3) large international rivers, Ganges, Brahmaputra (Jamuna), and Meghna, and the most south part is facing the Bay of Bengal. The area of Bangladesh is 147,570 km^2, of which most of the land is a low flat land (except the eastern hill side of the country). Total area of the catchment is 1.76 million km^2; however, the area of Bangladesh is only 7% of the total catchment area.



Source: BWDB

Figure 4-1 Ganges, Brahmaputra, and Meghna Catchments

(1) Geography and Geology

The low land coastal areas are still in the active delta formation phase due to the movement of the Ganges, Brahmaputram and Meghna rivers. These rivers flow along the hills of accreted sediment, forming natural embankments along the rivers in the delta. Flow decreases inversely to the distance to the main river, carrying capacity of the suspended substances also decreases in the order of sand, silt, and clay. Thus the most coarse-grained particles deposit first, generally the backswamp areas are formed with clay and fine silt, and the natural embankments consist of sand and coarse-silt.

The Delta plain is a repetitive formation combined movement of backswamp and natural embankments. The rivers in the Delta frequently change their flow paths, and gradually form the Delta. The alluvial river bed of those active rivers may be covered by sandy soils but the subsurface layer may consist of clay soils. Further, in some instances the lower layer of the clay soils in the backswamp areas show the evidence of the existence of a sandy layer alluviated in the past. Those soil layers have important roles as aquifers, which store rainwater during rainy seasons and use the water for irrigation during dry seasons.

The salt water intrusion is becoming a serious issue in the tidal floodplain. During the rainy season, the direct rain can provide fresh water for cultivation; however, during the dry season, surface water flow decreases and it causes saltwater intrusion. The southwest coastal areas have the most severe damage by salt water intrusion since there is not much water supplied from the

Ganges River. It is anticipated that the salt water intrusion may be expanded as the groundwater extraction for irrigation increases.

(2) Climate

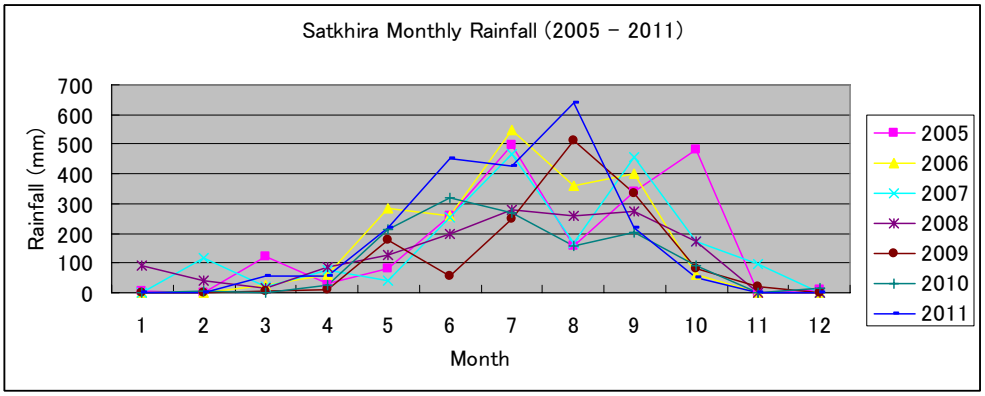
Climate in the whole of Bangladesh can be classified as a Monsoon Climate, which has frequent fluctuation of temperature and rainfall at each season. Bangladesh has the following four (4) seasons.

Table 4-1 Major Cyclones (1960 to 2009)

Season	Month	Features
Pre-Monsoon	Mar. to May	Very high temperature, very strong cyclone occurs especially in May
Monsoon	Jun. to Sept.	Heavy rainfall
Post-Monsoon	Oct. to Nov.	Similar to Pre-Monsoon, tropical cyclone may occur in the coastal zones
Dry Season	Dec. to Feb.	Cool and pleasant season

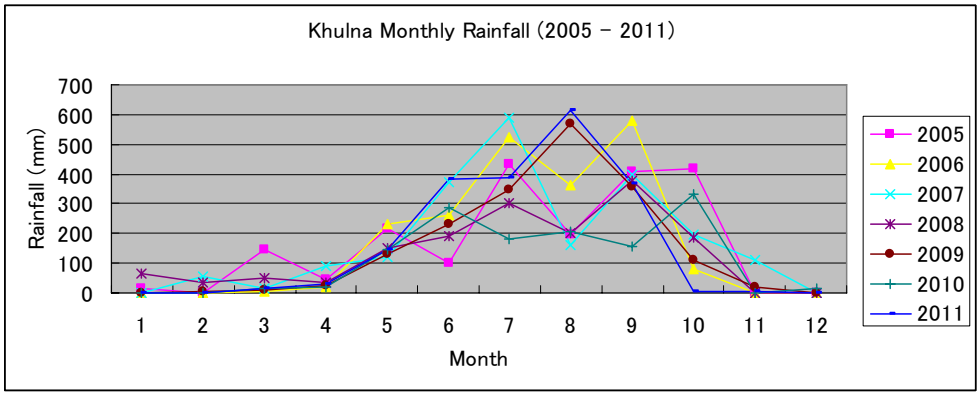
Source: BMD

From November to January, Bangladesh has almost no rainfall, and the dry period of 5-months is a harsh environmental condition for the rice paddies. Small amounts of rainfall in March and April in the graph below is recorded for squalls with thunderstorms.



Source: BMD

Figure 4-2 Monthly Rainfall observed at Satkhira Station (2005 to 2011)



Source: BMD

Figure 4-3 Monthly Rainfall observed at Khulna Station (2005 to 2011)

(3) Cyclones

Cyclones in the Bengal Bay generally occur in two (2) seasons, from April to May and October to November. Cyclones originate from low atmospheric pressures over the Bay of Bengal. Some bring damage to the Arabian Sea area by crossing over the Indian Peninsula, but most of the cyclones change direction from west toward north at the Bay, causing severe damage to Bangladesh. As shown in the table below, maximum wind speed of a cyclone can reach to 160 km/h.

Table 4-2 Major Cyclones (1960 to 2009)

Date	Cyclone	Affected Areas	Max. Wind Speed (km/h)	Tidal Surge Height (ft)	Central Pressure (mbs)
11.10.60	Severe Cyclonic Storm	Chittagong	160	15	-
31.10.60	Severe Cyclonic Storm	Chittagong	193	20	-
09.05.61	Severe Cyclonic Storm	Chittagong	160	8-10	-
30.05.61	Severe Cyclonic Storm	Chittagong (Near Feni)	160	6-15	-
28.05.63	Severe Cyclonic Storm	Chittagong- Cox's Bazar	209	8-12	-
11.05.65	Severe Cyclonic Storm	Chittagong-Barisal Coast	160	12	-
05.11.65	Severe Cyclonic Storm	Chittagong	160	8-12	-
15.12.65	Severe Cyclonic Storm	Cox's Bazar	210	8-10	-
01.11.66	Severe Cyclonic Storm	Chittagong	120	20-22	-
23.10.70	Severe Cyclonic Storm of Hurricane Intensity	Khulna-Barisal	163	Moderate	-
12.11.70	Severe Cyclonic Storm with a core of Hurricane Wind	Chittagong	224	10-33	-
28.11.74	Severe Cyclonic Storm	Cox's Bazar	163	9-17	-
10.12.81	Cyclonic Storm	Khulna	120	7-15	989
15.10.83	Cyclonic Storm	Chittagong	93	-	995
09.11.83	Severe Cyclonic Storm	Cox's Bazar	136	5	986
24.05.85	Severe Cyclonic Storm	Chittagong	154	15	982
29.11.88	Severe Cyclonic Storm with a core of Hurricane Wind	Khulna	160	2-14.5	983
18.12.90	Cyclonic Storm (crossed as a depression)	Cox's Bazar Coast	115	5-7	995
29.04.91	Severe Cyclonic Storm with a core of Hurricane Wind	Chittagong	225	12-22	940
02.05.94	Severe Cyclonic Storm with a core of Hurricane Wind	Cox's Bazar-Teknaf Coast	278	5-6	948
25.11.95	Severe Cyclonic Storm	Cox's Bazar	140	10	998
19.05.97	Severe Cyclonic Storm with a core of Hurricane Wind	Sitakundu	232	15	965
27.09.97	Severe Cyclonic Storm with a core of Hurricane Wind	Sitakundu	150	10-15	-
20.05.98	Severe Cyclonic Storm with core of Hurricane Winds	Chittagong Coast near Sitakunda	173	3	
28.10.00	Cyclonic Storm	Sundarban Coast near Mongla	83	-	-
12.11.02	Cyclonic Storm	Sundarban Coast near Raimangal River	65-85	5-7	998
19.05.04	Cyclonic Storm	Cox's Bazar Coast between Teknaf and Akyab	65-90	2-4	990
15.11.07	Severe Cyclonic Storm with core of Hurricane Winds **(SIDR)**	Khulna-Barisal Coast near Baleshwar river	223	15-18	942
25.05.09	Cyclonic Storm **(AILA)**	West Bengal –Khulna-near Sagar island	70-90	4-6	987

Source: BMD

4.1.2 Socio-Economic Condition

(1) Administrative Boundaries and Population

The Administrative Boundaries of Bangladesh consist of seven (7) divisions – Dhaka, Rajshahi, Chittagong, Khulna, Barisal, Rangpur and Sylhet. The target area of this survey, Khulna, Satkhira, and Bagerhat, is under Khulna Division jurisdiction. Each district has Upazila, Union, and Villages.

Source: CEGIS (Original Data), JICA Survey Team

Figure 4-4 Southwest Coastal Area (Khulna, Satkhira, Bagherhat) Unions

The table below shows areas, populations, and households at each Union in the southwest coastal areas (Khulna, Satkhira, and Bagherhat).

Table 4-3 Areas, Population and Households at each Union

District	Upazila	Number of Unions	Area (km^2)	Population (2001)	Estimated Population[5] (2011)	Number of Households (2001)
Khulna	Terokhada	6	189.48	110,628	118,856	21,391
	Batiaghata	7	248.32	140,574	154,208	29,799

[5] Estimated Population (2011) was estimated based on BBS (2001) and "2011 Population & Housing Census: Preliminary Results". The average annual growth rate (0.6 %) of 2001 – 2011 for Khulna Division is shown in the preliminary results.

District	Upazila	Number of Unions	Area (km^2)	Population (2001)	Estimated Population[5] (2011)	Number of Households (2001)
	Dacope	10	991.57	157,489	173,278	30,130
	Dumuria	14	454.23	279,862	305,488	58,729
	Dighalia	6	77.17	120,782	135,279	24,306
	Koyra	7	1,775.41	192,534	226,099	38,394
	Paikgacha	10	411.20	248,112	273,527	51,757
	Phultala	3	56.83	76,941	83,986	15,909
	Rupsa	5	120.15	167,604	186,980	34,369
	Daulatpur	1	11.81	118,380	172,554	26,423
	Khalishpur	-	11.47	235,018	318,924	53,818
	Khanjahan Ali	3	28.95	108,317	132,296	23,063
	Khulna Sadar	-	9.45	250,651	327,489	54,268
	Sonadanga	-	8.42	172,079	230,811	36,968
	TOTAL	**-**	**4,394.46**	**2,378,971**	**2,839,775**	**499,324**
Satkhira	Satkhira Sadar	17	400.82	410,355	489,054	87,112
	Assasuni	11	402.36	249,244	281,098	52,285
	Debhata	5	176.33	118,944	142,873	23,657
	Kalaroa	15	232.64	221,596	257,424	50,615
	Kaliganj	12	333.79	256,384	291,445	52,163
	Shyamnagar	12	1,968.24	313,781	371,395	59,885
	Tala	12	344.15	294,400	344,704	65,028
	TOTAL	**-**	**3,858.33**	**1,864,704**	**2,177,993**	**390,745**
Bagerhat	Bagerhat Sadar	10	316.97	257,273	280,552	54,465
	Chitalmari	7	192.00	139,862	153,427	27,986
	Fakirhat	8	160.68	134,418	145,711	29,076
	Kachua	7	131.62	100,093	107,431	21,766
	Moliahat	7	187.88	126,218	136,415	23,892
	Mongla	7	1,461.22	149,030	161,070	31,015
	Morrelganj	16	460.91	349,551	380,425	75,472
	Rampal	11	291.22	178,503	190,640	37,873
	Sarankhola	4	756.61	114,083	120,635	21,960
	TOTAL	**-**	**3,959.11**	**1,549,031**	**1,676,306**	**323,505**

Source: BBS 2001

(2) GDP

The table below shows a comparison of GDP of Bangladesh and southwest coastal areas. The GDP of Khulna, Satkhira and Bagherhat were USD 1,495 million, 792 million, and 742 million, respectively (2005/06), which account for 5% of the Bangladesh economy.

Table 4-4 GDP

	GDP (USD million)	
	2005/06	Increase Rate from 1995/96 (%)
Dhaka	9,497	66.2
Khulna	1,495	55.1
Satkhira	792	59.3
Bagherhat	742	59.4
Bangladesh	59,748	52.9

Source: UNDP

4.2 Damage by Cyclones "SIDR" and "AILA"

4.2.1 Cyclone "SIDR"

Cyclone "SIDR" developed in the Bay of Bengal on 11 November 2007, and made landfall in Bagherhat, coastal zone of Bangladesh. According to the simulation model estimated by the Institute of Water Modeling (IWM), the highest tidal surge reached 5.5m to 6m. The southwest area was hit by the cyclone and damaged severely.

In Bangladesh, the total damages are; Total Cost of Damages: 115,569 million Taka, Number of Victims (including missing persons): 4,507 persons, Number of Injured: 55,000 persons, Length of Damaged Embankment: 362 km, Length of Partially Damaged Embankment: 1,927 km.

4.2.2 Cyclone "AILA"

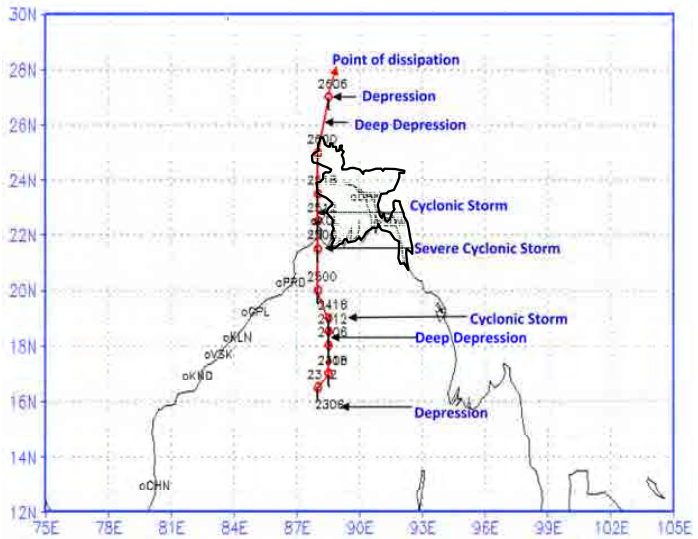
(1) Route and characteristics of Cyclone "AILA"

On 20 May 2009, a tropical depression developed in the Bay of Bengal south of Bangladesh and it moved north. The depression suddenly increased its speed of advance and made landfall on the west side of the Bay around 13:30 to 14:30 on 25 May.

AILA reached hurricane strength bringing heavy rains, wind and an enormous storm surge of seawater with height of 6 m that pushed inland by destroying the embankments, damaging the areas. Additionally, AILA remained for 15 hours and this made the damages more critical.

The area had not been hit by a cyclone since 1989, and in previous years there had been few cyclone disasters. Therefore, the area was not well prepared compared to the southeast and the south coastal zones, and this was one of the causes of the severe damage.

The route of the Cyclone "AILA" is shown below;



Note: The red mark "●" indicates the location of the cyclone for every 6 hours
Source: India Meteorological Department (2009)

Figure 4-5 The route of the Cyclone "AILA"

(2) Damage done by Cyclone "AILA"

The assessment report prepared by the UN Agencies explains the damage done by Cyclone "AILA". The southwest coastal area (especially around Khulna and Satkhira) was the worst hit area. The damage on polders was concentrated in the southwest coastal zones. BWDB estimated that BDT 60 million is required for the rehabilitation and reconstruction of the affected areas.

Table 4-5 Damaged by Cyclone "AILA" (whole of Bangladesh)

Types of Damages	Damage	
Deaths	190 persons	
Injured	Approx. 7,100 persons	
Affected Population	More than 3,900,000 persons	
Affected livelihood	Approx. 100,000 head-count	
Affected Households	Fully	243,191 households
	Partially	370,587 households
Damaged Embankment	Fully	237 km
	Partially	1,557 km
Damaged Cultivable Land	Fully	313.6 km^2
	Partially	995.4 km^2
Damaged Public Facilities	Fully	445 parts
	Partially	4,588 Locations
Damaged Roads	Fully	2,233 km
	Partially	6,621 km
Damaged Bridges and Culvert	Fully	157 Locations

Source: Cyclone AILA: Joint UN Multi-Sector Assessment & Response Framework (2010)

4.2.3 Damage to Three Districts in Southwest Coastal Area

(1) Damage in Khulna and Satkhira Districts

The table below shows the reported damage caused by Cyclone "AILA".

Table 4-6 Damage Caused by Cyclone "AILA"

Damage		Khulna	Satkhira
Number of Damaged Unions / Total Number of Unions in the District		45 / 70	10 / 79
Number of Affected Households / Total Number of Households in the District		122,672 / 499,324	132,544 / 390,745
Number of Affected People / District Population		546,630 / 2,378,971	569,810 / 1,864,704
Area of Damaged Agricultural Land (ha) / Total Area of Agricultural Land in the District (ha)	Full	81,200 / 158,283	― / 128,157
	Partial	45,300 / 158,283	― / 128,157
Number of Damaged Houses (House)	Full	106,325	68,721
	Partial	49,195	44,313
Number of Dead (Person)		57	59
Number of Injured (Person)		543	1,509
Number of Lost Livestock (Head-Count)	Cow	904	2,080
	Poultry	30,238	33,276
Number of Damaged Educational Institutions and Religious Facilities (Number of Facility)	Full	136	13
	Partial	598	569
Damaged Roads Length (km)	Full	179.75	372
	Partial	149.5	627
Damaged Bridges (Location)		5	41
Damaged Embankment Length (km)	Full	35.9	597
	Partial	256.52	―
Damaged Shrimp Cultivation Pond (Location)		―	26,027
Number of Evacuated Population (Person)		38,000	33,950

Note: "-" indicates that the data was not available, or the data obtained was not reliable
Source: Obtained from Khulna DC Office and Satkhira DC Office

4.2.4 Damage to the Polders

(1) Outline of Damage of 12 Polders Designated for Survey

As indicated in Table 4-7, the JICA survey team undertook site survey for the designated 12 polders in total in this stage, in which the 6 polders were requested by BWDB head office for its rehabilitation to JICA in August 2010 and the other 6 polders were additionally requested by BWDB O&M division offices in Khulna, Satkhira and Bagerhat in the course of site survey.

Table 4-7 Designated Polders for Survey

District (Zila)	BWDB O&M Division Office	Polders Designated		
		Polders Originally Requested to JICA in Aug. 2010	Additional Polders Requested to JICA During the survey	Polders Designated for Survey
Satkhira	O&M Division 1	15	3, 5	3 Polders
	O&M Division 2	7/1, 7/2, 13-14/2, 14/1	4	5 Polders
Khulna	O&M Division 2	32	31	2 Polders
Bagerhat	O&M Division	-	35/2, 36/1	2 Polders
Total		6 Polders	6 Polders	12 Polders

Source: JICA Survey Team

The damage to the polders can be classified into the following four (4) groups in view point of configuration of damages mainly in inundation and river bank erosion aspects.

1) Five (5) polders 7/1, 13-14/2, 14/1, 15 and 32, which had serious inundation damage and continuous river bank erosion issues.

Due to cyclone AILA, entire areas of respective polders were completely inundated with brackish waters due to the destruction of the embankments, and it took 14 - 34 months to prevent intrusion of brackish waters by emergency rehabilitation of the embankments/closures.

2) Five (5) polders 3, 4, 5, 7/2 and 31, which had inundation damage in confined areas, and continuous river bank erosion issues.

Partial areas of respective polders were inundated with brackish waters due to collapse and/or overtopping of the embankments, and it took for 0.5 – 7.0 months to prevent intrusion of brackish waters by emergency rehabilitation of the embankments/closures.

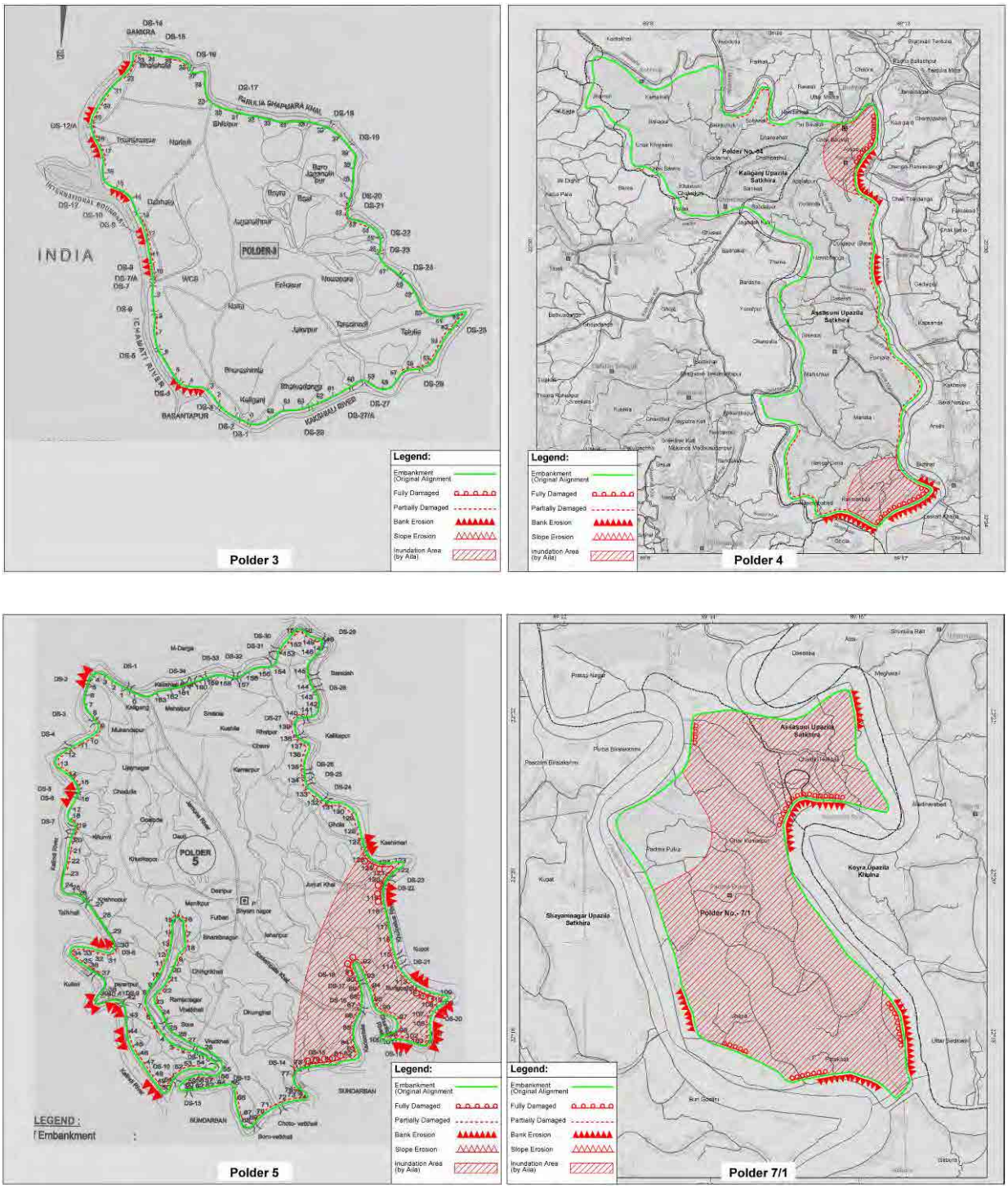
3) One (1) polder 35/2, which had serious inundation damage and continuous bank erosion issues. There is no large-scale polder system constructed by BWDB.

There exists only one small-scale polder system constructed by local governments, or NGOs, or local residents, *etc*., but no full-scale polder has yet been constructed by BWDB. So the polder has frequent inundation problems through intrusion of brackish water. During cyclone AILA, the entire area of the polder was inundated.

4) One (1) polder 36/1, which polder had serious monsoon inundation and continuous bank erosion issues.

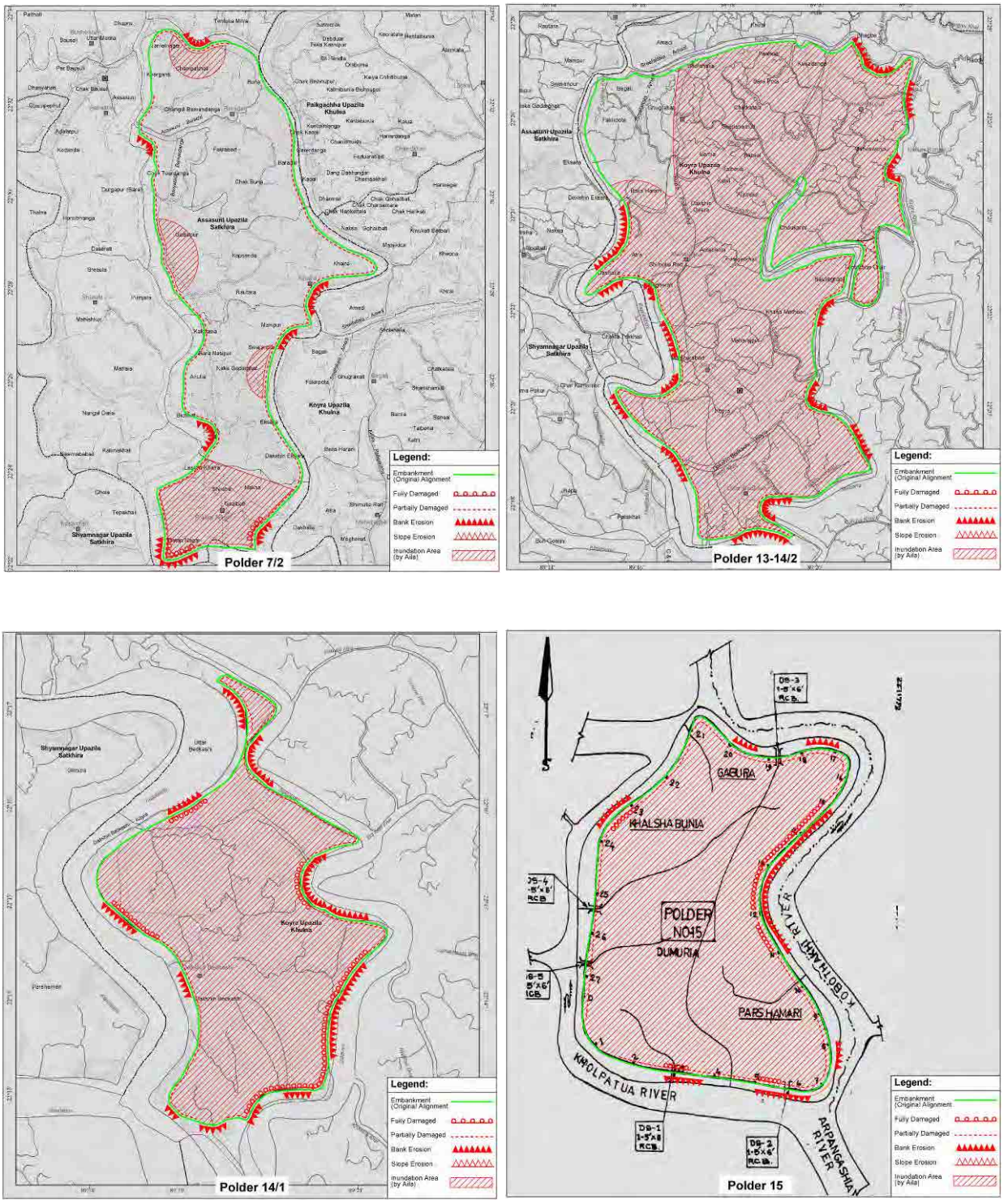
Stagnant rain water is the most critical problem of this polder, which is caused by siltation of the drainage canals in and around the polder and deterioration of the drainage facilities. During cyclone AILA as well as every rainy season, a large area of the polder is inundated with rain water for two (2) months more or less.

The following drawings indicate the configuration of damages for the respective 12 polders due to cyclone AILA.



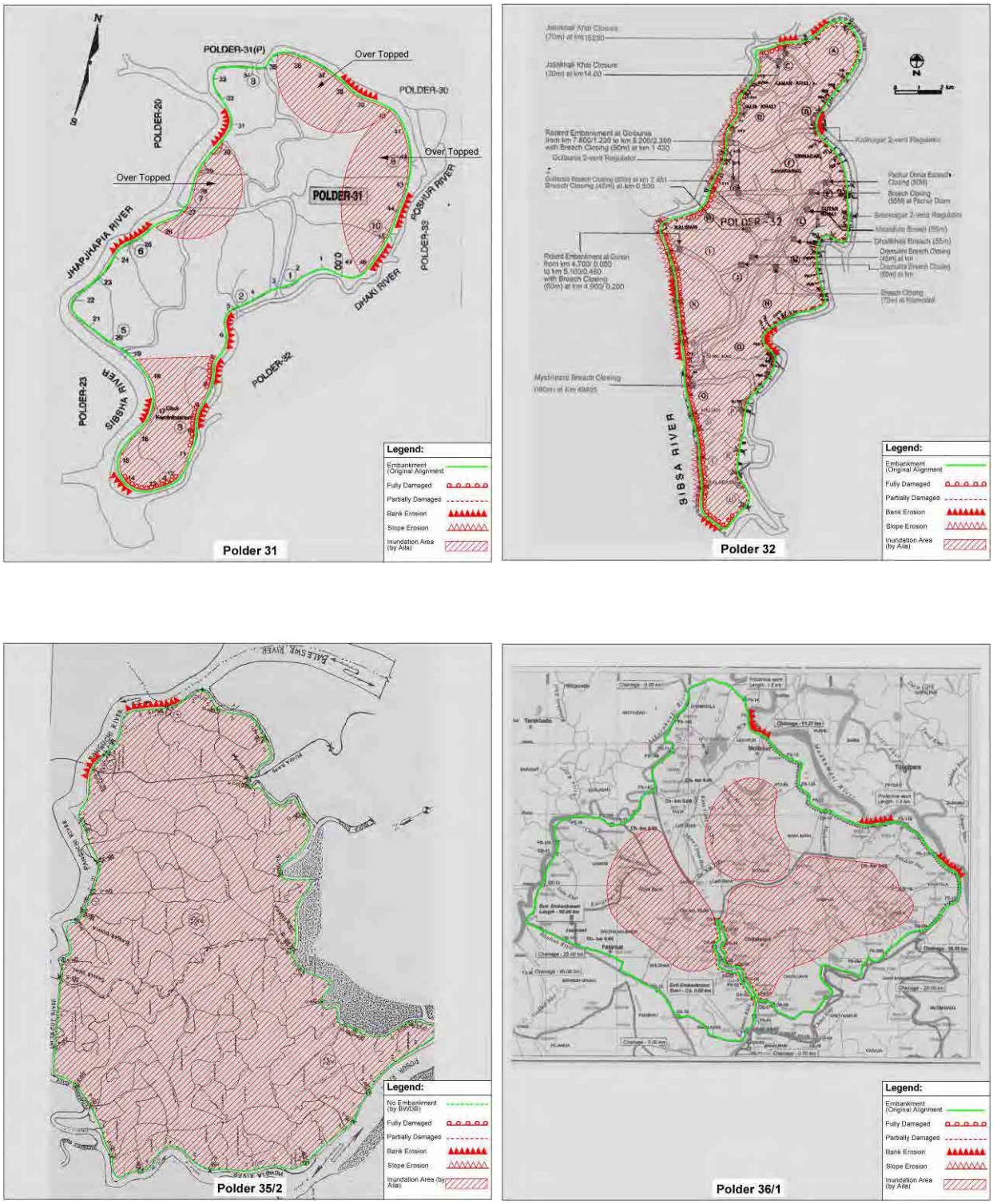
Source: BWDB O&M division offices

Figure 4-6 Polder Damage by Cyclone AILA (3, 4, 5 and 7/1)



Source: BWDB O&M division offices

Figure 4-7 Polder Damage by Cyclone AILA (7/2, 13-14/2, 14/1 and 15)



Source: BWDB O&M division offices

Figure 4-8 Polder Damage by Cyclone AILA (31, 32, 35/2 and 36/1)

4.2.5 Damage and Issues in terms of Water Resources Management and Environmental Sector

Cyclone "AILA" caused severe damage to the southwest coastal regions, such as shortage of drinking water due to destruction of water supply facilities, and salinity intrusion. In this section, water resources management and environmental issues are shown in the list below. The issues are not limited to the damage done by Cyclone "AILA".

Table 4-8 Damage and Issues in terms of Water Resources Management and the Environmental Sector

Water Supply Facilities	After Cyclone "AILA", DPHE, donor agencies, and NGOs have implemented rehabilitation of water supply and sanitation facilities but, just like other infrastructure, the affected sites have not fully recovered yet. Damaged water supply facilities were observed at several locations at the time of the field survey in April 2012.
Salinity	The Polders 『7/2』, 『14/1』, and 『15』 needed two (2) years for construction of temporary embankments, and suffered from desertification due to salinity intrusion for a long period of time.
Accretion of sediment on the river bed	Situated in the Gorai floodplain, and due to river sedimentation, the river bed has risen year by year, which causes frequent flooding in the rainy seasons, while the area suffers from drought during the dry seasons. The drainages in the polders do not have adequate capacity due to congestion.
Inundation during Rainy Season	Apart from the cyclone damage, one of the critical issues in the area is flooding for several months in the rainy seasons due to sedimentation, drainage congestion, and facility deterioration.
Environmental Conservation	Bangladesh has regulations for conservation of coastal aquaculture and land use; however, those are not effective.
Diarrhea	Number of patient on June, 2009 (a month later of cyclone AILA) was more than three times compared to the past years.

Source: JICA Survey Team

5. Polder Facilities and Operation/Maintenance Activities

5.1 Fact-Findings Based on Interview with Bangladesh Government Personnel

5.1.1 Designated Polders for Survey

As shown in Table 5-1, the four (4) BWDB's division offices in three (3) districts of khulna, Satkhira and Bagerhat in the southwest region of Bangladesh, have thirty eight (38) polders that they are responsible for and, those polder areas and embankment lengths are 458,900 ha and 1,798 km in total respectively.

Of which, the polders 34/2 and 37 in Bagerhat are still under construction and not completed yet. In addition, the construction of polder 35/2 in Bagerhat is unsure when it will start, so there is no BWDB's polder facilities constructed in this polder.

Table 5-1 Polders under Jurisdiction of Four (4) BWDB's Division Offices in 3 Districts of the Southwest Region

District (Zila)	BWDB O&M Division Office	Number of Polder	Total Area (ha)	Embankment Length (km)	Remarks
Satkhira	O&M Division-1	4	109,555	377	-
	O&M Division-2	7	72,416	412	-
Khulna	O&M Division-1	-	-	-	Not include for survey in this stage
	O&M Division-2	15	68,712	511	-
Bagerhat	O&M Division	12	208,217	498	Three polders are not completed in construction
Total		38	458,900	1,798	-

Source: JICA Survey Team

5.1.2 Polder Facilities

The polders designated for survey are located in tidal flood plains near the southwest coast of Bangladesh, and the internal land elevation of the polders is lower than high tide. Therefore, the entire polder area would be submerged by daily tidal surge if there would be no provision of a dike embankment system enclosing the polder. (Average land elevation is +1.2 m PWD, while tide ranges from -0.5m to +3.5m PWD)

As shown in table 5-2, taking the characteristics of the tidal flood plain into consideration, the major polder facilities consist of the embankment to prevent intrusion of the external brackish water, the river bank protection to prevent erosion of the embankment and river bank, the regulator to control drainage and to prevent external water from entering, and the drainage canal collecting and discharging internal excess rain water through the regulator. However, no pumping stations for discharging the excess rain water have been provided in the southwest region.

Table 5-2 Major Polder Facilities in the Southwest Region

Polder Facilities	**Embankment**	Earth dike surrounding the polder area to prevent ingress of external brackish water
	River Bank Protection	Composite type revetment with CC block and sand-filled geo-bag protection to prevent erosion of the embankment and river bank
	Regulator	Control gate to drain and to prevent ingress of external blackish water
	Drainage	Canal collecting and discharging internal excess water to regulator

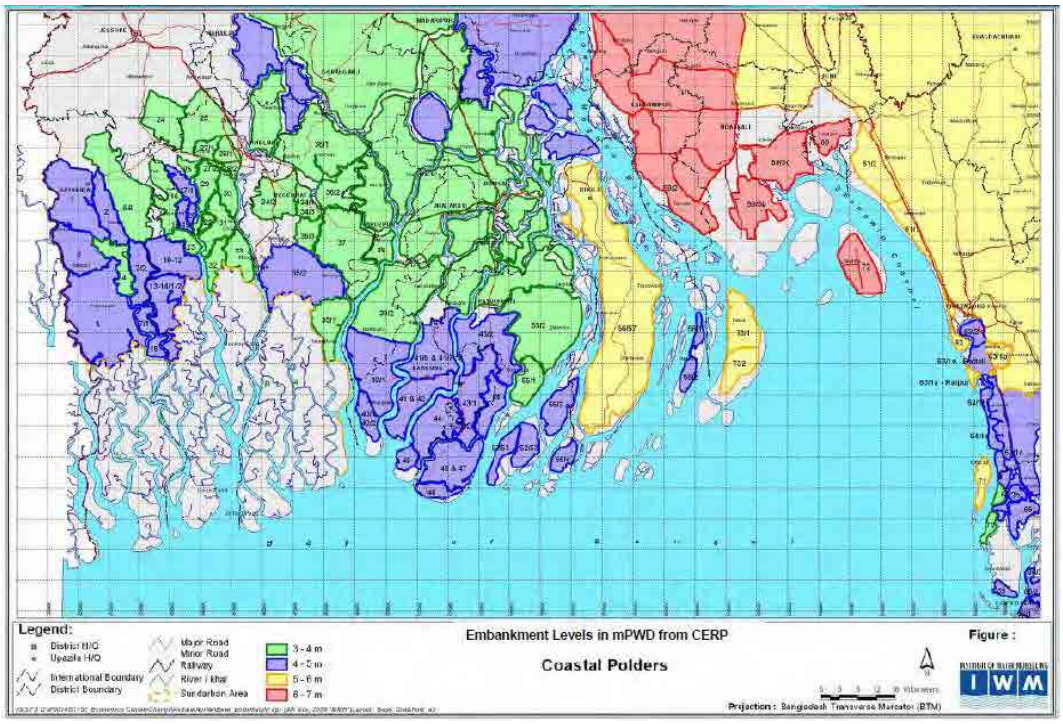
Source: BWDB O&M Division Offices

5.1.3 Safety Degree of Existing Polder

The crest level of the polder embankments in the coastal area of Bengal bay varies in the range of 3～7m PWD, which successively changes from the lower crest level of 3~5m PWD in the southwest region to the higher crest level toward the east; 5～6m PWD in east part of Barisal Division, then 6～7m PWD in the west part of Chittagong Division (refer to Figure 5-1 and Table 5-5).

Furthermore, the crest level of the embankment in the southwest region had not taken into consideration wave run-up or cyclone tidal surge, in addition, the design tide levels were adopted based on only short term observation results of 1960-1968. Therefore, BWDB has decided to take a higher degree of safety for the crest level of the embankments than the existing one for the medium and long term improvement of polders in the southwest region.

The on-going project of CEIP-1, based on this BWDB's safety improvement decision, has considered wave run-up, water level rise due to climate change, and the cyclone tidal surge of 25 year frequency into the crest level of embankment design.



Source：CEIP-1 Mid-Term Report

Figure 5-1 Coastal Embankment System

Table 5-3 Crest level of Existing Polder Embankments in the Southwest Region

District (Zila)	BWDB O&M Division Office	Crest Level of Embankment (PWD)	Remarks
Satkhira	Division-1	4.27 m	The crest level of 4.57m is adopted only for polder-5 embankment along Kalindi river at the Indian border.
	Division-2	4.27 m	-
Khulna	Division-2	4.27 m	-
Bagerhat	Division	4.27m－4.88m	-

Source: BWDB O&M Division Offices

5.1.4 Operation and Maintenance

Four (4) BWDB's O&M division offices have implemented the operation and maintenance of thirty eight (38) polders in the southwest region. However, at every disaster, it is pointed out from both inside and outside of BWDB that its activities are inadequate, which is mainly caused by restriction of budget, shortage of staff, lack of equipment, *etc*.

According to the interview with the BWDB's O & M division offices, the present staff number of 30 more or less allocated in the respective offices, including executive engineer, technical and administrative staff, and site supporting staff, are only 20-30 % of the required number of staff to take appropriate O&M activities. Furthermore, the restricted budget, which allocated only 20 % of the requested amount, is indeed the critical condition for the proper O&M activities. Also the shortage of equipment such as vehicles, motorcycles, motorboats, *etc*. is a hindrance to implement O&M works.

Under these circumstances, BWDB has set forth strategy to introduce a people's participation scheme for operation and maintenance of the entire BWDB's infrastructure in the country. The people's participation scheme was individually studied in the past under the projects of WSIP (WB), IPSWAM (ADB), SWIWRMP, and JMREMP with assistance of WB, ADB, *etc*. From now on, BWDB plans to apply the results from these projects nation wide.

5.1.5 Guidelines and Manuals

With the financial assistance of WB, BWDB published the first edition of the Standard Design Manual in 1994, which contains wide aspects of river engineering such as flood control, embankments, river bank protection, drainage, regulators, pipe, irrigation, roads and bridges.

On the other hand, both FAP21/22 projects compiled Guidelines and a Design Manual for Standardized Bank Protection Structures in 2001 with the financial assistance of KfW and AfD. These are the specialized guidelines and design manual for river bank protection. River bank erosion is one of the most critical issues in the country. In 2008, JMREMP (Jamuna-Meghna River Erosion Mitigation Project) project with the assistance of ADB, also compiled similar Guidelines for River Bank Protection, based of the results of the project implementation.

In 2010, BWDB continuously compiled and published the Guidelines for River Bank Protection with the assistance of ADB through the JMREMP project. This 2010 Guideline contains planning, design and construction aspects, including general river characteristic analysis, hydrology, hydraulics, river bank management. And this introduced sand-filled geotextile bag protection works which was the first time in the country.

5.2 Site Survey in the Southwest Region

5.2.1 Polder Embankment

After the AILA disaster, BWDB has been implementing re-sectioning work on the embankments at the site, and a considerable length of embankment section has already been recovered to the originally constructed condition in height, width and slope. It is on the dissolving stage of issues of embankment deficit and crest level lowering.

However, the sections where re-sectioning works have not been implemented are still in a dangerous condition. They do not have proper free board allowance and the high tide water level almost reaches the crest of the embankments. Especially, of the 12 polders on which the site survey was conducted, the polders 7/1, 14/1 and 15 still have sections with a high risk of collapse and/or overtopping by the tidal surge in various places, if a cyclone of a scale similar to AILA would occur. Some embankment sections that experienced extensive river bank erosion, have again started eroding, even after finishing the re-sectioning works.

The construction works in the southwest region, has been mainly conducted by manual methods, not mechanical methods, so that void spaces can remain in the earth filling embankment due to insufficient compaction. This can cause the weakening of the embankment and bring about lowering the crest level and/or sewage frailer. Also adjustment of water content and/or grain size has not been conducted to construct a hard body embankment. Furthermore, collapses frequently occur in the composite type of revetment that is used for river bank protection works, since the embankments that have a 1:3 slope, on which the revetment would be constructed is not compacted enough.

5.2.2 River Bank Erosion

As for the operation and maintenance of polders in the southwest region, the river bank erosion is the most critical issue, which could be broadly divided into two types: surface erosion of banks and mass failure of banks, in view of the mechanism and process of bank erosion.

The surface erosion of the banks, which is caused mainly by wave loads generated by wind/boats in the larger and/or wider rivers, can break and/or collapse the embankment. The mass failure of banks is caused mainly due to scouring that occurs at the outer bank of a meander bend, which would suddenly bring about collapse of the embankment, sometimes with 10-20m width of bank, in an instant. As for the emergency rehabilitation works after the AILA disaster, BWDB has implemented the construction of the river bank protection at some sections. Due to restrictions of budget, however, there still remain many sections which have not had any counter measures implemented and still have a risk of collapse of the embankment.

Table 5-4 shows BWDB's counter measures against the surface erosion of banks at the site. Mangrove forests, which are low cost measures, are effective to mitigate the surface erosion of the banks.

Table 5-4 Counter Measures for Surface Erosion of Banks at the Site

River Bank Protection for Surface Erosion	• Sand Bag Protection • Bamboo Matting (Bandals) • CC (cement Concrete) Block Protection • Mangrove Forest Protection

Source: BWDB O&M division offices

As for the mass failure of banks, BWDB has taken two counter measures: construction of river bank protection and construction of retired embankments. The river bank protection, which includes the alternatives of revetment type, groyne/spur type, *etc*., has technical difficulties and

is higher in cost than the retired embankment. Therefore, BWDB has adopted the retired embankment method at many bank erosion places as the counter measures of erosion.

Table 5-5 Measures for River Bank Erosion Recognized at Site

BWDB's Counter Measures for River Bank Erosion	(1) CC Block Revetment Bank Protection (2) Retired Embankment

Source: BWDB O&M division offices

5.2.3 Revetment for River Bank Protection

BWDB has widely adopted the composite type revetment as one of BWDB's standard designs of river bank protection works in the southwest region, by which the slope above the low water level is protected with CC (cement concrete) blocks mainly to resist wave action, and the slope below LWL is protected from current erosion/scoring with sand-filled geotextile bags.

However, in the southwest region, it is reported that there are many cases of collapse of this composite type revetment within a few years after the construction and /or even within 1 year. Although it is envisaged that one of the causes would be inadequate operation and maintenance activities at the site, it is desired to survey and establish a more stable and firm river bank protection, by inspecting the collapse site, to clarify the causes of collapse, and to review the BWDB's standard design of composite type revetment, if necessary. For seeking the methodology for a more stable and firm river bank protection, it is required for utilizing the indigenous and low cost materials.

5.2.4 Regulators

Many regulators in the southwest region have not functioned properly due to the damage by cyclone AILA as well as the deterioration of facilities, which have been in operation for over 30-40 years since construction. BWDB has been replacing the regulator facilities, one after another. However, it is not coping with the requirements due to the restriction of the budget. It is, therefore, obliged to make shift with emergency measures, such as installation of temporary gate leaves made of wood replacing the decayed steel gate leaves, utilizing rope lifts as a substitution for the damaged lifting equipment, *etc*. Also the steel bars that have been exposed due to concrete exfoliation of the gate piers, are left without being repaired.

At the places where internal water can not be drained due to the damage of the culverts and/or have intensive leakage problems, BWDB has enclosed them completely by construction of embankments to prevent intrusion of external blackish water, so it is liable to create stagnant water and inundation problems during the rainy season.

The polder facilities in the southwest region were originally designed and constructed mainly to drain excess water from the farm lands, so they have no function for taking the external blackish water into the polder. However, the demand has arisen to improve the function of the existing regulators, on account of the fact that the land use of considerable area has already been changed into fish cultivation. To bring external brackish water into the area for fish cultivation, the people have used ropes to lift and open the flap gate leaves.

5.2.5 Drainage Canals

The drainage canals, which have been in operation for more than 30-40 years since construction, would have not drained properly due mainly to canal bed rise through siltation. This has brought about water stagnation and inundation during the rainy season. Though the siltation problems have arisen in various polders, the problems are the most serious in polders 1, 2, 3 and 6-8 in the northern area of Satkhira, and at polders 34/2 and 36/1 in the northern area of Bagarhat.

5.3 Issues and Needs of Assistance Identified from Interview Survey and Site Survey

5.3.1 Full-scale Improvements of Polders

After the AILA disaster, BWDB has decided to implement three (3) stages of recovery works based on the survey result of the internal committee: the first stage undertakes emergency works to prevent intrusion of external brackish water, the second stage executes rehabilitation works to recover to the originally constructed condition, and the last stage implements the full-scale improvement works. The on-going projects being implemented in the southwest region include only urgent works as defined in the first and the second stages. Then BWDB has intended to implement the full-scale improvement works as the third stage, with technical and financial assistance from foreign donors.

The full-scale improvement works include not only rehabilitation of polder facilities recovering to the previous condition, but also re-construction of deteriorated facilities, improvement of the degree of safety with higher crest level and construction of additional internal dikes, review of the polder system considering the land use changes, sea water rise due to climate changes, improvement of compaction method for the embankments, prevention of land erosion by construction of river bank protection, establishment of mangrove forests along the polders and also drainage improvement with construction of additional regulators.

As the full scale work, BWDB's rehabilitation/improvement program, CEIP-1 project has been implementing with the World Bank assistance. At present, an international consultant has been employed for the Feasibility Study and Detailed Design, and by the end of June 2012, the first stage final report will be compiled. However, the CEIP-1 project has been undertaken for only 17 polders, of BWDB's 139 polders. Assistance for the full-scale improvement works of the other polders from the international donors is desired.

5.3.2 Standard Design of River Bank Protection Works

BWDB has published the specialized guidelines for planning and designing of river bank protection works, as indicated in the previous section 5.1.5, owing to the fact that the river bank erosion is the most critical issue in river works not only in the southwest region but also in the whole country.

The guidelines have considered the previous project publications and collate available research data and technical information together with practical experience gained by the practitioners and designers of BWDB. In order to utilize cheaper local materials for standard designs, it introduced the use of geo-bags, which are new construction materials, placed at random below the water level, though the CC (cement concrete blocks) are placed on the slope of the river bank above the water level. Taking this standard design, the river bank protections at both banks for Jamuna Bridge were constructed and maintained well without any problems, even 15 years after construction.

However, it could be seen in various places in the southwest region that the river bank protection has collapsed within a few years after the construction. It would be pointed out that those river bank protections were constructed in unstable places, where river bank erosion has intensively progressed and the maintenance works has not implemented properly. However, it is required to investigate and clarify the causes of collapse, study the improved alternatives, implement pilot projects and monitoring, and then propose the improved standard design of river bank protection works.

For this purpose, in view point of BWDB technical institutional strengthening, it is desired to bring in personnel that have discernment and experience in planning, design, construction and maintenance on the river bank protection, with good understanding of river characteristics.

5.3.3 Changes in Function of the Regulators

The existing regulators have the function to drain the rain water automatically, however, as for taking external brackish water for fish cultivation, it is necessary to operate the gates manually. The flap gate, which is installed on the river side of the regulator, was originally designed to operate automatically in accordance with the water level deference between the inside and outside of the polder. So that to bring external brackish water into the polder, it is required to open this flap gate manually, since the existing flap gate has no function for intake. Therefore, it is desired to construct a regulator which has both functions of drainage and water intake, taking into consideration both agriculture and fish culture activities.

5.3.4 Construction Method of Embankment and River Bank Protection

Most of the embankment in the southwest region has been constructed manually without mechanical compaction of the earthfill or adjustment of the water content and/or grain size, which has caused weakening of the embankment. Due to inappropriate construction of the embankment earthfill where the CC blocks and geo-bags are placed for the river bank protection, frequently the river bank protection together with the embankment slope collapses. It is required to establish the proper construction method for the embankment taking into account construction circumstances in the southwest region.

BWDB has adopted the composite type of revetment, as one of the standard designs of river bank protection, which has an advantage in utilization of indigenous material. Above LWL, it places CC block on the slope, and below LWL, it places sand-filled geotextile bags by random dumping.

However, it is difficult to confirm the effects of placing of geotextile-sand-bags, since the diver can not work in the water due to much suspended sediment in the rivers. It is desired to establish the proper construction method, which can confirm the effectiveness of random dumping of sand-filled geotextile bags.

5.3.5 Operation and Maintenance

Due to budget restraints, shortage of staff, lack of equipment/facilities, *etc*, the operation and maintenance activities implemented by BWDB are not sufficient for the polder facilities. If the proper operation and maintenance could be provided for the polders in the southwest region, the resulting mitigation of the risk of blackish water damage could provide safer activities for the people and stabilization of the people's livelihood, and also it can be the basis of eradication of poverty in the region.

Under the present circumstances on operation and maintenance of the polders, it is important to introduce a people's participation scheme, to train BWDB's young technical staff and strengthen the institution, develop systematic guidelines and manuals for O&M, study how to secure a revenue source to eliminate the restrictions of the O&M budget, so as to sustain the polder system in the southwest region.

5.3.6 Counter Measures for Floating People

Against the bank erosion issues, BWDB has adapted two methods as counter measures in the southwest region: the retired embankment method and the river bank protection method. Mostly, however, the retired embankment method has been adopted more than the bank protection method, on account of the fact that the bank protection works would require high cost under the confined budget.

However, the retired embankments method forces abandonment of a huge area of land as well as resettlement of people. Furthermore, it has brought about floating people who have lost their

lands and houses, and then have no place to live. This is one of the biggest social problems in Bangladesh, since there is no proper compensation system.

To mitigate the adverse impacts of the retired embankment method, it is desired to support establishment of a compensation system for abandonment of land and resettlement, as well as preparation of hazard maps and enlightenment of the people.

6. Community-based Disaster Risk Reduction

6.1 Outline of Village Survey of Inhabitants in Damaged Polders

The village survey was conducted with the residents of 8 polders of the 12 target polders of this data collection study to understand response/awareness of the residents regarding the cyclone that struck the village, the actual situation of the affected villages in the aftermath of the cyclone disaster, the situation of the reconstruction of life in the villages, and the difficulties/needs of residents *etc*. for consideration of the course of future assistance as Community-based Disaster Risk Reduction. The target areas and methodology of the Village Survey are as follows;

Table 6-1 List of Target Areas of the Village Survey

Survey point No.	Polder No.	Date of Survey (2012)		Name of Survey Area			
		Interview Survey (Qualitative Research)	Questionnaire Survey (Quantitative Research)	District	Thana	Union	Village
1	7/1	20th March	1st April ～3rd April	Satkhira	Shymnagar	Padmapukur	Kerdar Bazar
2	7/2	20th March	27th March ～31st March	Satkhira	Shymnagar	Padmapukur	Banyatala
3	14/1	21st March	4th April ～7th April	Khulna	Koyra	Dakshin Bedkashi	Patakhali
4	15	21st March	8th April ～10th April	Satkhira	Shymnagar	Gabura	Jaliakhali
5	4	22nd March	11th April ～25th April	Satkhira	Assasumi	Pratap Nagar	Hizla
6	13-14/2 ①	24th March	26th April ～28th April	Khulna	Koyra	Mahessoripur	Mathbari
7	13-14/2 ②	24th March	29th April ～3rd May	Khulna	Koyra	Maheshwaripur	Shinger Chak
8	32 ①	7th May	4th May ～8th May	Khulna	Dacope	Sutarkhali	Gunari
9	32 ②	9th May	4th May ～8th May	Khulna	Dacope	Kamar Khola	Jaliakhali
10	31	10th May	9th May ～13th May	Khulna	Dacope	Tilldanga	Kaminibashi

Source: JICA Study Team

Ten villages, which were affected by cyclone “AILA” in May 2009 and have been rehabilitating their lives, were selected as target areas (villages) in 8 polders.

Table 6-2 Outline of Survey Methodology

Survey Type	Respondents of Survey	Survey Methodology	Main Survey Contents
Interview Survey	One household in each selected village became the respondent. Therefore, in total 10 households are targets of the interview survey.	Japanese expert confirms detailed information with residents in the target villages (Qualitative Research)	Situation of cyclone disaster, situation of affected villages, response/evacuation behavior when cyclone struck in the village, situation of alarm and evacuation system, situation of communication system of disaster information, situation of existing community-based disaster risk reduction system, situation of emergency assistance after cyclone struck, situation of reconstruction of life, needs/difficulty of residents, *etc*.
Questionnaire Survey	Thirty households, which were selected at random within 100m radius from the point of the Interview survey, became respondents in each of the selected villages. Therefore, a total 300 households are targets of the Questionnaire survey.	Based on the questionnaire, the survey assistants confirm information with the residents and complete the questionnaire (Quantitative Research).	

Source: JICA Study Team

The village survey was conducted in a combination of two kinds of survey methodology such as Interview survey (Qualitative Research) and a Questionnaire survey (Quantitative Research). In the Interview survey, the Japanese expert confirmed detailed information with the affected residents (households) in the villages directly. On the other hand, in the Questionnaire survey, the survey assistants confirmed the cyclone disaster situation, affects of the disaster, situation of emergency assistance, situation of reconstruction of life, and so on.

6.2 Result of Village Survey

The situation of residents when cyclone “AILA” struck, situation of assistance after the disaster, and reconstruction of life which were clarified through the Village survey are as follows;

6.2.1 Early Warning System and Communication System to Residents

An early warning system for reduction of cyclone/flood damage is established in Bangladesh. The Cyclone alarm is distributed to residents through DMCs in order of District, Upazila and Union. Six respondents of 10 residents answered “Confirmed information of cyclone before” and 4 respondents in the Interview survey did not get information about the cyclone. According to the Questionnaire survey, the ratio of respondents who could get information about cyclone “AILA” was 24% of total respondents (300 residents), and 76% of respondents could not get information of early warning about cyclone “AILA”. In the case of the residents who could get information before the cyclone struck, most respondents got the information about the cyclone in radio broadcasts or MIC broadcast. Speakers in the mosque, television, neighbours, and local governmental office *etc*. were given as information sources regarding the cyclone. Eight respondents (11%) in 71 respondents, who could get information about cyclone “AILA”, were asked about the earliest information that they received and they answered “2 days before”. Respondents who answered “1 day before” to get information about cyclone “AILA” were 22 residents (31%). Respondents who answered “12 hours before” were 8 residents (11%), “6 hours before” were 7 residents (10%), and “1 hour before” were 26 residents (37%). The number of respondents who got information about cyclone “AILA” in Polder No. 4 and Polder No. 13-14/2 were few and they got their information “before 6 hours”. The issue of the effective cyclone information communication system remains.

Also there is the Cyclone Preparedness Program (CPP) by Bangladesh Red Crescent Society (BDRCS) in Bangladesh, and it functions as an early warning for residents in coastal areas. However, CPP did not work because “There is no CPP for southwest Bangladesh (Khulna, Satkhira, and Bagerhat) “.

6.2.2 Evacuation Awareness/Behavior of Residents

As mentioned above, one of the causes that prevented advanced evacuation by the residents was that the early warning was not distributed promptly. It is understood through the Interview survey that most residents in target areas did not evacuate to safety before the threat to life was close to them and then they evacuated with only the barest necessities. According to the result of the questionnaire survey, 17% of the total 300 respondents evacuated before the tidal wave that was caused by the cyclone, and most respondents (83%) started to evacuate after the tidal wave came close to the residents. Early warning could not accomplish "Advance evacuation behavior by residents". In the Interview survey, answers of residents such as "They worried about losing property and livestock due to the destructive storm and tidal wave", "They could not bring property, food, and livestock in the evacuation", "They thought it would be no problem because they did not suffer damage in the former cyclone (SIDR)", "There was no cyclone shelter or it was far from the house", "There was no space in the nearest cyclone shelter because of a lot of evacuees", "No evacuation road was ever built and they could not walk because of flooding", "It was difficult for women to access the cyclone shelter" came up as reasons that they did not evacuate sooner. According to the result of the Questionnaire survey, the five main reasons of the 81 respondents who did not evacuate sooner, are "Losing house and other properties" (36%), "Distance to Evacuation place" (31%), "Worry about separating family" (13%), "Road condition to evacuation place is bad" (12%), and "Losing livestock" (11%). Also "Distrustfulness about alarm", "Payment for using shelter", "Allah's intent" *etc*. come up as less frequent answers.

6.2.3 Evacuation Place for Residents

Cyclone shelter, Other's house, Community building, Top of embankment, and Top of tree, *etc*. were mentioned for evacuation places of residents in target areas. Some of the residents did not evacuate but rather stayed in their house when the cyclone struck. According to the result of the Questionnaire survey, 49% of the 300 respondents evacuated to the Top of the embankment. The embankment was flooded by the tidal wave produced by the cyclone and was at risk for the dyke to break. However, it is also nearest emergency evacuation place or evacuation road for residents who evacuated at the tidal wave's approach in front of them.

18% of the respondents' answer is "Cyclone shelter" as evacuation place. In general, it is thought that the cyclone shelter is the safest evacuation place. However, there are not enough cyclone shelters in target areas, and the distance is more than 1 km from the residential houses in the target village to the nearest one in another village. The roads to such nearest cyclone shelters are not developed and are flooded by the tidal wave in a cyclone disaster. Also, it is extremely difficult to evacuate in a hard rainstorm. Also residents mentioned "Capacity of facility is not enough for a lot of evacuees", "There is no drinking water" and "The shelter can not be used because of flood water", "There are not enough toilets and they are not separated for men and women.", "It is difficult for woman to use.", "There is no stock of food or drinking water.", and "O&M of facilities were not carried out appropriately for time of disaster" *etc*. as issues regarding the cyclone shelters.

On the other hand, some of respondents in the Interview survey evacuated to a neighbour's house or the nearest public building (*e.g.* mosque, school *etc*.) which were made of concrete or brick. Also in the result of the Questionnaire survey, 17% of respondents of the total 300 residents evacuated to Other's house which was made of concrete or brick and strong.

6.2.4 Situation of Life and Reconstruction of Life after Cyclone Disaster

After the cyclone disaster, the emergency assistance started in the target areas. Rice and drinking water were rationed by the government, NGO, and donor countries *etc*. They continued to assist for 1 month to 6 months after the cyclone. In the target areas, residents have to travel

by boat on the water and by motorcycle taxi on the embankment in the normal times. Therefore, accessibility in the target area is paralyzed by tidal wave flooding or dyke break during and after the disaster. It took more than 1 month to distribute emergency assistance goods in some of the target areas. Therefore, it was learned through the Interview survey that many residents had been hard pressed to obtain food and drinking water during and after the disaster. According to the Questionnaire survey, in addition to food assistance such as rice, drinking water, oil and wheat, commodities such as tents, plastic sheets, blankets, cooking tools, and livestock were rationed as emergency assistance goods. Assistance for reconstruction of life such as providing monetary donations, and assistance with replacement of houses which were washed away by the tidal wave were also carried out in the target areas. The flooding due to the tidal wave continued for a long time after the cyclone. Therefore, most residents lived in a cyclone shelter, someone else's house (Friend's house), or on top of the embankment. Some residents lived outside of the village after the cyclone.

In addition, there are residents who still can not use their agricultural land or their land flooded by the tidal wave in the target areas. Most of these residents earn a living by participating in "Cash for Work" or "Food for Work" which is managed by an NGO or through irregular daily labor work after the cyclone. According to the explanations of the residents, some families received money from family members who work in urban areas in Bangladesh or a neighbouring country such as India as guest labourers. Reconstruction of life is not proceeding because agricultural activities *etc*. and income has decreased since the cyclone.

To cover the costs of reconstruction of their lives, most residents use their own money or micro credit. According to the result of the Questionnaire survey, most respondents who use micro credit borrow money from a big steel micro credit organization such as Ganamukhi, BRAC, Gramin Bank, ASA, Krishi Bank, and BRDB. These organizations gave extensions of the repayment period for money which had been borrowed before the cyclone until residents can get things sorted out. On the other hand, some of the residents did not use micro credit because their livestock would be forfeit if they could not pay back these organizations. They borrowed money from village organizations for reconstruction of their houses. Also daily labourers could not borrow money from most of these micro credit organizations.

6.3 Difficulty and Needs extracted through Village Survey in terms of Community-based Disaster Risk Reduction

The main issue and assistance needs as community based disaster risk reduction for flooding/cyclones in the target areas which were revealed through the village survey are as follows;

6.3.1 Necessity of Strengthening the Distributing System for Early Warning Information

When cyclone "AILA" struck in the target areas, distribution of the early warning information about the cyclone to the residents did not operate timely or properly. The early warning system of Bangladesh through the Disaster Management Committee of the District, Upazila, and Union should be improved for certain distribution of information. In addition to the implementation of CPP by BDRCS in the target areas, it is necessary to strengthen the system of information distribution to the residents reliably and early by using community radio or creating an information distribution system coordinated with religious facilities or public facilities such as the mosques or schools in the village. The existing early warning signal has 11 levels in coastal areas. It is difficult to understand the proper evacuation behavior to respond to each level, and the residents did not understand adequately. And most residents in the target areas can not read or write. The evacuation behavior to be followed for each early warning signal should be

reviewed and presented in a manner which can be understood by even small children, and it is necessary to sensitize the residents.

6.3.2 Development of Cyclone Shelters to Reflect the Intention of the Residents

Many cyclone shelters were constructed in various locations in Bangladesh. However, there are absolutely not enough cyclone shelters in the target areas. The capacity of necessary facilities such as toilets, are not adequate compared with the number of residents. Also, the cyclone facilities are too far from residential houses for speedy evacuation. The fact that the residents can not bring property such as food and livestock with them discourages evacuation. Therefore, it is necessary to develop cyclone shelters which residents can travel to and use easily; *e.g.* to set up a greater number of smaller cyclone shelters very close to the residential houses that are easy to access, and to improve the necessary facility such as wells and water tanks for drinking water and toilets *etc*., and to design facilities for easy use by women, and to secure space for property and livestock. Consideration must be given to equipment for refuge during and after a disaster, to stock foods *etc*. Also it is necessary to develop cyclone shelters which have other functions such as schools, clinics, public centres, disaster prevention centres, water supply facilities, and consolidation points for agricultural products. The residents are supposed to make proper operation & maintenance of a shelter, since the shelter is usually utilised by the surrounding residents or community.

6.3.3 Necessity of Education and Sensitization regarding Disaster Prevention for Residents

In the target areas, the residents, who understood the cyclone early warning information, did not evacuate to a safe place soon enough. To protect their houses, properties, and livestock, most residents repaired the embankment, and only evacuated after the threat to life was close to them. Based on the experience of the former cyclone (SIDR), some of the residents did not evacuate based on self-judgment. As mentioned in 6.3.1, the early warning signal and descriptions of evacuation behavior should be improved. Education and sensitization is needed regarding disaster prevention and the threat posed by natural disaster such as cyclone/flood, confirmation of early warning signals, preparedness for a disaster, and advance evacuation before a disaster. In addition to 6.3.2, there is a need for training/activity for O&M of cyclone shelters and O&M/daily inspection of the embankments rather than rushing to repair them after damage during a disaster.

6.3.4 Rehabilitation/Strengthening of Polder including Evacuation Road

The polders were established to protect residential life including houses, agricultural land, and aquacultural ponds. In target areas, the embankment is also used by the residents as community roads or evacuation roads to a safe cyclone shelter during a cyclone/flood. The height of the existing embankment is enough for the ebb and flow of the river. But it is very low, and easy to break routinely by hydraulic action. In the Interview survey, most respondents requested the height and width of the embankment to be expanded and strengthened. When the cyclone struck the village, the top of the embankment was flooded by water. It was difficult to walk on the slippery embankment in the strong wind. In some cases, the polder road was impassable due to the dyke breaking. In addition to protection of houses and agricultural land from tidal waves, it is necessary to rehabilitate the embankment so that they are higher and more robust than the existing embankment to protect the evacuation road.

In Bangladesh, construction and large-scale rehabilitation of embankment are implemented by BWDB. At community level, a Water Management Group (WMG) should be established by the residents and they should manage daily O&M and simple repair. According to the interview

survey, most villages in the target areas have not established any WMG. Some of the villages have a WMG, but no actual activity has not implemented. On the other hand, in some of the villages, which have no WMG, residents collect money from rich persons, and bought necessary material for repair, and repaired the embankment by themselves after damaging of the embankment by cyclone, *etc*. It is necessary to consider the role and responsibility of WMG in cooperated with Union Parishad.

6.3.5 Livelihood Improvement/Income Generating Activity for Residents

The income sources of residents in the target areas are limited to primary industry such as agriculture and fishery, and daily labor in civil work. After the disaster of cyclone “AILA”, the government, donor countries, and NGO carried out emergency assistance and reconstruction aid to the residents in the target areas. Currently, the residents are undertaking reconstruction of their lives using their own money or micro credit. However, some of the residents can not cultivate agricultural products because their agricultural land was inundated by salt water from the tidal wave of cyclone “AILA”. Therefore, daily agricultural activity has been reduced. Therefore, some of the residents can not undertake reconstruction of their lives because their income decreased after cyclone “AILA”. Also, the target areas have a lot of various difficulties such as water and sanitation issues, energy issues in the form of power/fuel source shortages, and nutrition/health issues. In such situations that require improvement in terms of basic life, solar panels and related equipment were distributed to the residents as emergency assistance by NGO after cyclone “AILA”. Therefore, some of the residents use the solar panels for lightning and have to pay off the loan used to cover the cost by making monthly payments.

In addition, consideration must be given to the environment of the residents' lives and income generation activities to prepare for the mitigation of natural disasters in addition to the reconstruction of the residents' lives and rural development. These activities should be sustainable and easy to do for anyone with their ingenuity. Therefore, it is necessary to improve the living environment and the water and sanitation environment devising/using existing resources; *e.g.* to secure drinking water using rain water, use solid fuel made of rough rice, and so on. Also it is necessary to engage in activities such as nutrition improvement by taking various agricultural products with rice, and income generation activities such as primary food processing adding value to existing agricultural products and farm-raised shrimp.

Local governments such as District, Upazila and Union are expected to assist the activities at community level by the residents, however NGOs have played important roles in fact.

7. Issues and Possible Countermeasures against Cyclone Disaster in Coastal Areas in Bangladesh

7.1 BWDB's Request for JICA Assistance and its Significance

After the cyclone "AILA", which caused devastating damage to the southwest coastal zones, the GOB (BWDB) requested assistance from the GOJ in August 2010, to rehabilitate the infrastructures in six (6) polders where the damages were the most severe. In response to the request, the Survey Team has been dispatched to carry out "Data Collection on Strengthening of Disaster Tolerance in Cyclone Affected Area" for formulation of possible assistance.

In this section, Bangladesh's disaster control for cyclones and support needs, and purpose of the supports are explained.

(1) Southwest Coastal Zones and the Survey Areas

The Bangladesh coastal zones consist of 19 districts with a population of approx. 35 million and area of 47,200 km^2 (30% of the total population and 30 % of the total landmass of Bangladesh). Main industry in this area is agro-aquaculture which plays an important role in the socio-economy. In order to protect the coastal zones from tidal surge and flood, embankments have been constructed for the past 30 years, and presently, there exist 139 polders. These areas are designated as high risk areas, especially the east and south coastal zones, which have been frequently hit by cyclones. In response to the devastating damage done by the cyclone in 1970, causing over 300,000 deaths, the number of deaths and affected populations have decreased as a result of implementation of disaster controls in the southeast coastal areas.

The Survey Areas (Khulna, Satkhira, and Bagherhat) of the southwest coastal zones, with population of 5.8 million and area of 12,200 km^2, comprises of 26% and 17% of the coastal zones, respectively. BWDB has requested assistance for nine (9) polders[6] from GOJ, having a total polder population of 1 million (estimate) and area of 2,090 km2, which comprises of 3% and 4% of the coastal zones, respectively. These areas, Khulna, Satkhira, and Bagherhat in the southwest coastal zones, have not been hit by cyclones since 1989; however, Cyclone "SIDR" in 2007 and Cyclone "AILA" in 2009 caused severe damage to the areas. Especially the damage by the Cyclone "AILA" was devastating in the southwest coastal zones. Polder [7/1], [13-14/2], [14/1], [15], [32] in the south part of Khulna and Satkhira suffered catastrophic damage by salt water inundation due to embankment destruction. The inundation depth reached 2.0 – 2.5 m, taking a long period of time for closing the gate, two (2) years for the construction of temporary embankments, and two (2) and a half years for the polder [14/1]. Even now, the areas still suffer from desertification and lack of drinking water due to salinity.

(2) BWDB's Approach and other Donor's Actions for the Recovery of Polders

In order to mitigate the damage, BWDB has recognized that there is an urgent need for improving the embankments by strengthening the bank structures and raising the bank height. Total cost for the rehabilitation of the entire damaged embankments, with a length of 5,100 km and related structures (water gates and drainage) at 13,000 locations is estimated to be BDT 160 billion. It is difficult for BWDB by itself to implement all the necessary rehabilitation works; and therefore, the World Bank declared that it would provide support (CEIP: Coastal Embankment Rehabilitation Project), and has been implementing the rehabilitation projects with up to USD 375 million. The CEIP selected 17 polders, and among those, chose 5 polders[7] for the detailed design, and is implementing feasibility studies for the rest of the 12 polders[8]. The

[6] Polder [3], [4], [7/1], [7/2], [13-14/2], [31], [35/2], [36/1]
[7] Polder [32], [33], [35/1], [35/3], [39/2C]
[8] Polder [14/1], [15], [16], [17/1], [17/2], [23], [34/3], [40/2], [41/1], [43/2C], [47/2], [48]

CEIP has considered raising the bank height so that they can withstand the storm surge, which includes surge due to climate change. The Dutch government also stated that it would provide support, named the "Blue Gold Programme", which will select 18 polders from the 24 nominated polders, and strengthen the structures and raise the height of the embankments (details will be further discussed).

(3) BWDB's Request for Assistance from the GoJ and its Significance

BWDB has a clear intention of early rehabilitation and improvement of the embankment, and has expressed a strong need for assistance for the improvement of the nine (9) polders from the GoJ. Since AILA, due to the delay in rehabilitation works, there was a prolonged period with saline water in the areas, causing desertification which makes it difficult to sustain living in the polders. Considering this situation, the Survey Team believes it needs immediate assistance. By promoting a partnership with the other donors and government agencies such as World Bank, the Dutch government, and BWDB, the polder rehabilitation projects can be carried out more efficiently.

Further, it is important, not only to protect the areas from the disasters, but also to implement an integrated approach to develop the protected areas, ultimately leading to the economic development of Bangladesh as a whole.

7.2 Issues and Possible Countermeasures against Cyclone Disaster in the Coastal Areas in Bangladesh

7.2.1 Embankments

(1) Countermeasures for Deteriorated Structures, and Full-Scale Improvement Plan which includes Flood Control

Current Issues and Direction for the Assistance

Since Cyclone "AILA", BWDB has implemented three-phase countermeasures – "(Early) Emergency Relief Measures", "Emergency Rehabilitation", and "Improvement Plan". It is now time for the "Improvement Plan".

Related Organization Activities

- The CEIP, supported by World Bank, has been implementing the feasibility survey and detailed designs. The target polders selected are 17 polders among the 139 polders under control of BWDB.
- The Blue Gold Program, supported by the Dutch government, selected 24 polders for assistance. Among those, 18 polders will be selected for improvement of the embankments (raising the height and strengthening of the structure).
- BWDB has requested assistance from JICA for nine (9) polders[9]

(2) Standard Designs for Prevention of River/Slope Erosion

Current Issues and Direction for the Assistance

River erosion control is one of the major issues in Bangladesh, and GoB is preparing the guidelines. In order to provide solutions to multiple issues, BWDB needs organizational strengthening and capacity development for each phase – plan, design, construction, and repair/maintenance of erosion controls.

[9] Polder [3], [4], [5], [7/1], [7/2], [13-14/2], [31], [35/2], [36/1]

Related Organization Activities

- BWDB, supported by World Bank, prepared a Standard Design Manual in 1994 (first edition)
- Guidelines and Design Manual for Standardized Bank Protection Structures was prepared by FAP21/22 supported by German KfW and French AfD in 2001
- Similarly, Guidelines for River Bank Protection was prepared by JMREMP, supported by ADB in 2008 based on lessons learnt from the implemented projects. In 2010, the Guideline was edited and re-issued.
- There are not so much assistance experiences for strengthening structural measures (*e.g.* embankments, protection works, *etc.*) by GoJ in the south-west coastal region. However, it is possible for JICA to utilize the abundant know-how of similar past experiences in Japan or the other developing countries. JICA can assist BWDB for enhancement of technical capacity considering the current working process of BWDB (*e.g.* plan, design, construction, and repair/maintenance of erosion controls, *etc.*).

(3) Construction Procedures for Embankments and River Bank Protection

Current Issues and Direction for the Assistance

Most of the embankment in the southwest region has been constructed manually without mechanical compaction of the earthfill or adjustment of the water content and/or grain size, which has caused weakening of the embankment. It is required to establish the proper construction method for the embankments taking into account construction circumstances in the southwest region (manual labor, lack of construction machinery, *etc*).

Related Organization Activities

- CEIP under WB assistance may well implement advanced mechanical compaction method for construction/improvement of embankment. The details have not yet been confirmed.
- JICA has not yet provided any assistance for construction/improvement of embankment in the region. However, the past experiences and advanced technology, which have been applied successfully both in Japan and the other countries, can be applied.

(4) Countermeasures for the Floating People

Current Issues and Direction for the Assistance

In order to mitigate the negative impact by implementing the Retired Embankments, support or some kind of compensation system for the relocated population are required. For a long term solution, development of hazard maps or promotion of awareness regarding the erosion is needed.

Related Organization Activities

- A Bangadesh NGO (ACR) has been assisting the floating people by the fund from Australia or WB. (The details are unknown.)
- A total solution is required in terms of poverty reduction, thus the assistance from JICA may well be given in this field.

(5) Operation and Maintenance System

Current Issues and Direction for the Assistance

The operation and maintenance carried out by BWDB are often criticized due to limited budget, lack of employees and lack of machinery. The operation and maintenance of the constructed

structures (*e.g.* embankments, water gates, *etc.*) has been tried to be strengthened by community participation. It is necessary to establish or strengthen operation and maintenance activities in a sustainable way.

Related Organization Activities

- Presently WMIP, supported by World Bank, provides support to strengthen the community participation in operation and maintenance for the constructed structures (embankments, water gates, *etc*)
- In the past, the IPSWAM program, supported by the Dutch government, provided support for capacity development of water management groups in nine (9) polders in the south and southwest coastal zones. The Blue Gold Program continues the improvement efforts.

(6) Feature Change of Water Gates (Regulator)

Current Issues and Direction for the Assistance

Construction of water gates which have multi-functions (drain and water-intake) is required, corresponding to the recent land use change.

Related Organization Activities

As an emergency support, ECRRP, supported by World Bank, provided support for rehabilitation of damaged water gates and added improved functions to the gates.

7.2.2 Structural Measures inland of the Polders

(1) Infrastructures inland of the Polders

Current Issues and Direction for the Assistance

The inland embankments shall have additional functions such as roads or evacuation routes, so that the polders have multiple protection systems against cyclones. The infrastructure development in the polders shall be promoted ensuring safety and effectiveness.

(2) Accretion of Sediments on River Beds

Current Issues and Direction for the Assistance

River bed elevations have been rising gradually due to sediment accretion, causing flooding in rainy seasons and water logging in dry seasons, and drainage congestion in the polders. BWDB has implemented Tidal River Management (TRM) projects. The rivers can be dredged during dry seasons but there is not enough machinery (pumps, dredgers, *etc*).

Related Organization Activities

Dredging projects, supported by World Bank and the Dutch government, will be implemented for 5 years on the Gorai River.

7.2.3 Cyclone Forecasting and Warning System

Current Issues and Direction for the Assistance

There are various issues related to the cyclone forecasting and warning systems. The information transmitting for cyclone forecasting and warning systems through disaster management committees of the District, Upazilas, and Unions shall be improved and assured. The CPP practices shall be familiarized within the communities. The communication systems shall be strengthened so that the information can be transmitted steadily by establishing the

communication structures among the public facilities or utilizing community radio. Further, community awareness shall be promoted.

Related Organization Activities

- JICA, most recently, implemented a grant aid project, "Improvement of the Meteorological Radar System at Cox's Bazar and Khepupara" from 2004 to 2008 and the similar project at Moulvi Bazar from 2006 to 2008 for BMD as well as current technical assistance project for strengthening meteorological observation, forecasting and early warning from 2009 to 2012.
- The JICA project also has been preparing implementation of early warning services by making use of SMS in coordination with CDMP under UNDP, MoFDM, DMB, BMD, the private telephone companies.
- Flood Forecasting & Warning Center (FFWC), under BWDB, is designated as the Flood Information Center at the time of emergency such as cyclone or flood. The FFWC has received technical/financial support from UNDP, WMO, and DANIDA.
- The CPP is going to establish CPP offices in the southwest coastal zones

7.2.4 Cyclone Shelters

Current Issues and Direction for the Assistance

The number and size of the cyclone shelters are not adequate in the areas. The cyclone shelters shall be located in close proximity to the houses with easy access. The shelters shall have functions that the communities can utilize during the normal times, and which can be maintained by the community.

Related Organization Activities

- Construction of cyclone shelters has been implemented by support from JICA, World Bank, BDRCS, Saudi Arabia, the Swiss, *etc* in the coastal zones (east and south). LGED is the leading organization for the cyclone shelter construction.
- JICA Grant Aid: The Programme for Construction of Multipurpose Cyclone Shelters in the Area Affected by the Cyclone SIDR (combined with educational facilities) has been implemented in 4 districts, Patuakhali, Barguna, Pirojpur, and Bagherhat for
- BDPC constructed shelters based on the community needs, supported by the Swiss (SDC) through construction of cyclone shelter programs.
- UNDP and BRAC have constructed disaster tolerant family shelters (2 stories)

7.2.5 Evacuation Routes

Current Issues and Direction for the Assistance

Most of the roads are not paved; and therefore, the people cannot use the unpaved roads, which is very slippery when it is wet by rainfall, for evacuation during the time of disaster in many cases. It is important to pave the roads, and raise the levels slightly so that the evacuation routes for the polder dwellers are assured.

7.2.6 Disaster Education

Current Issues and Direction for the Assistance

It is important to promote disaster education and capacity development regarding the awareness of natural disasters, assurance of warning signals, preparedness, and evacuations. Further,

instructions/activities on regular maintenance and monitoring of cyclone shelters shall be implemented for their sustainable use.

Related Organization Activities

The Dutch government has provided IPSWAM assistance programs for disaster education and capacity development for water management groups of 9 polders in the south and southwest. The Blue Gold Program is going to continuously support the improvement; however, the target field of support is water management (embankments and water gate rehabilitation) and disaster control is not included in the program.

7.2.7 Drinking Water and Water Utilization

Current Issues and Direction for the Assistance

Since AILA, the access to drinking water is still limited in the affected areas. Some people walk a long distance for fetching water, or fetch untreated water directly from the ponds. There have been several conflicts between farmers and fishers for use of salt water in the polders. Regarding the drinking water, albeit a long term approach, there needs to be improvement of the water supply facilities and extension of water distribution pipes. Further, knowledge and technologies from the private sectors (rainwater harvesting, pond water treatment, desalination plants, *etc*) would be other options. Also taking brackish water at the high tide for the use of irrigation shall be considered.

Related Organization Activities

- DPHE has provided surface water treatment facilities for supplying an appropriate amount and quality of drinking water
- After Cyclone “AILA”, WHO, and many NGOs have provided salt removal plants, which are maintained by DPHE and Local Government
- There have been many JICA experts in the field of water supply and sanitation and arsenic removal in the southwest coastal areas

7.2.8 Salt Damage

Current Issues and Direction for the Assistance

Salinity on the soil surface was observed in several locations during the site survey, especially in Polders 15, 14/1, 7/2, extended areas of the surface soil were covered with salt. In order to mitigate the salinity, there needs to be an adequate amount of surface water flow and adequate drainage. In the areas where drinking water is not available, immediate solutions shall be provided such as deep tubwells, ponds, and elevated water tanks with filtration ponds. For agricultural sectors, innovative methods, such as salt-tolerant crops and appropriate land zoning systems shall be introduced.

Related Organization Activities

- One of the GoB government agencies (Soil Research Development Institute: SRDI) has prepared a monitoring report on salinity

7.2.9 Poverty Reduction and Regional Development

Current Issues and Direction for the Assistance

Means of income generation in the target areas are limited to primary industry workers and daily labourers such as construction works. After cyclone “AILA”, due to the decrease in their income, some affected populations are having difficulties in rebuilding their lives. Along with promoting safety against disasters, it is important to implement regional development leading to

poverty reduction in the target areas. For example, introducing processing plants for adding value to the primary industries such as crops and shrimp may be one of the options. For a long term solution, it is important to create more employment opportunities in the areas.

Related Organization Activities

- The ECRRP, supported by the World Bank, provides assistance for reconstruction of livelihood for the affected populations and rehabilitation of the damaged infrastructure, and long term support for countermeasures against disasters and restructuring of the management system.
- FAO has provided emergency relief and long term support for income generation right after cyclone “SIDR” in the south of Bangladesh.

8. Possible Assistance by JICA in the Future

The previous chapter mentions the issues and the possible countermeasures against future cyclone disasters. In this chapter, the possible assistance by JICA in the future, particularly the assistance programs which have the highest priority and urgency are presented.

In order to show the possible assistance by JICA focusing on the prioritized and urgent programs, the issues and countermeasures mentioned in the previous chapter are evaluated as target candidates from the aspects of "1) Enhancement of disaster management capacity of Bangladesh", "2) Short, middle and long term assistance" and "3) Efficient assistance by Japan".

"1) Enhancement of disaster management capacity of Bangladesh" was evaluated in view of implementation capacity (*e.g.* institution, budget, technology, *etc.*) and capacity enhancement in the field of disaster management. "2) Short, middle and long term assistance" consists of "Necessary to be implemented in Short-Middle Term" and "To be implemented in Long Term". "3) Efficient assistance by Japan" was evaluated considering "Utilization of Japanese technology", "Experiences of assistance by Japan" and "Self-sufficiency of Bangladesh with minimum input".

As a result of the evaluation and the considerations for the possible future assistance by JICA, the followings can be recommended by the Survey Team.

- Rehabilitation of Embankment and Improvement of Safety Level
- Construction of Multipurpose Cyclone Shelters at Community Level
- Establishment of Disaster Resilient Community Centred on the Cyclone Shelter

8.1 Rehabilitation of Embankment and Improvement of Safety Level

As mentioned in the previous chapter, CEIP by WB, and the Blue Gold Programme by the Netherlands have planned projects for dike enhancement and bank raising, while BWDB stated that they would request assistance for a total 9 polders[10] from JICA. The approximate project cost of the project is estimated at around 15 to 20 billion yen[11].

A package of a development study type technical assistance, grant-aid and yen loan is preferable as assistance by JICA. Pilot projects (*e.g.* a project targeting at polder "7/1") will be implemented by the development survey and grant-aid for the capacity enhancement at each process, including rehabilitation of aged dikes and safety improvement. The yen loan project (*e.g.* a project targeting 8 remained polders) utilizes the know-how gained by the development survey and the grant-aid project. It is important to cooperate with the relevant agencies or projects, such as CEIP by World Bank, *etc*.

It is one of the possible options that Japanese technology such as utilization of steel sheets and steel pipe piles, armor levees and super dikes can be utilized for constructing the structures for dike protection against external forces (erosion, high tide). However, the construction cost will be at least 10 times higher than the cost of typical methods in Bangladesh. It could be 100 times higher if a large number of steel sheet and steel pipe piles are used. Agriculture and fish farming cannot be changed drastically to other livelihoods in the dike protected area. Thus, it is not a realistic solution to introduce these advanced technologies considering the cost and benefit including the necessary cost and skill for maintenance.

BWDB formulated the guideline for riverbank erosion protection in 1993. After the assistance of JMREMP, the guideline was revised in May 2010. In BWDB, the process and role-division

[10] Polder "3", "4", "5", "7/1", "7/2", "13-14/2", "31", "35/2", "36/1"

[11] Based on rough cost-estimation for polder 7/1 by BWDB officers and expected total project cost of CEIP for 17 polders

of survey, design, quantity survey, construction, and operation and maintenance are clearly defined. The possible JICA assistance in this field is to improve the function and safety of dikes in view of the current status of the guideline for riverbank erosion protection.

8.2 Construction of Multipurpose Cyclone Shelters at Community Level

It is necessary to prepare the necessary facilities and equipment with the cyclone shelter which enable easy evacuation. For instance, the cyclone shelters which are not large but are easy to access for the people, wells and tanks for drinking water and toilets, devices and ideas to make women's evacuation easy, evacuation space (killa) for personal properties and livestock, facilities concerning not only evacuation but also refuge life and food stocks.

Cyclone shelters should be facilities which can be utilized in normal life such as schools, hospitals, city halls, disaster management centres, water stations, and farmers' collection centres, considering sustainable operation and maintenance. Local people's opinions on the facilities will be confirmed before construction in order for them to have adequate ownership and run the facilities by the whole community.

It is possible for JICA to utilize the abundant know-how of past cyclone shelter constructions.

8.3 Establishment of Disaster Resilient Community Centred on the Cyclone Shelter

As long-term countermeasure against cyclone disasters, it is necessary to develop infrastructure inside the polders from the viewpoint of safety improvement against cyclone disasters. For instance, height raising of embankment, roads and residential areas, construction of culverts, drainage channel, and water channel networks can be considered in an integrated manner and areas surrounded by inland embankment and roads can be utilized as storage reservoirs and ponds. The inland levee will be used as a road and evacuation route so that an inland multiple protection system can be realised especially for the area where the height raising of embankment or strengthening are difficult options to be implemented.

Multi-purposed cyclone shelters can be utilized in communities as a symbol of this promotion. Refer to Figure 8-1 showing an image of disaster resilient community centred on the cyclone shelter.

A mutual communication network will be installed in the cyclone shelters in each community in order to include the function of Emergency Operation Centre (EOC) in the shelters. Additionally, securing drinking water by utilizing rain water, generating electricity by using solid fuel made from rice husks, improvement of the living environment and sanitation by applying the local resources and techniques can be possible.

A series of these activities will be conducted not at once as a short term project but introduced gradually as middle and long term projects. It is expected that not only the promotion of safety improvement countermeasures against disasters but also poverty reduction and community or regional development in the safety-improved area will be achieved near in the future.

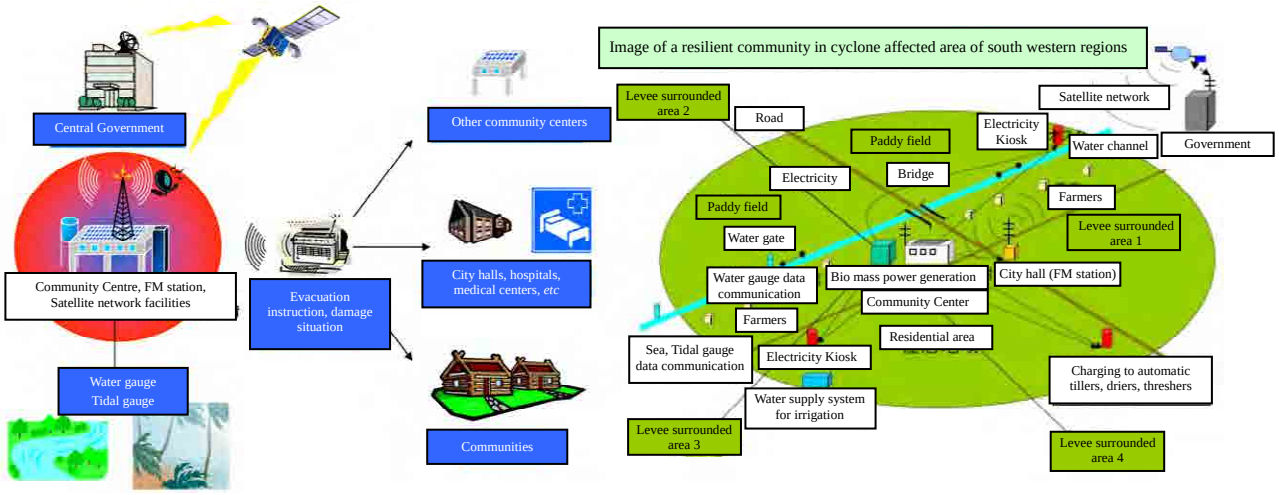


Figure 8-1 Image of Disaster Resilient Community centred on the Cyclone Shelter