Comprehensive Disaster Management Programme (CDMP)
Improved Adaptive Capacity to Climate Change for Sustainable Livelihoods in the Agriculture Sector (Phase II)

Final Report

Adaptive Learning in Climate Risk Management: Reflections on Capacity Building of Livelihoods Adaptation to Climate Change (Phase-II) in Bangladesh

March, 2010

Submitted by:
Asian Disaster Preparedness Center
(ADPC) Thailand

Project Implementing Partners:
Department of Agricultural Extension (DAE)
Food and Agriculture Organization of the United Nations (FAO)
Asian Disaster Preparedness Center (ADPC)

Comprehensive Disaster Management Program (CDMP)
Improved Adaptive Capacity to Climate Change for Sustainable Livelihoods in the Agriculture Sector (Phase II)

Final Report

Adaptive Learning in Climate Risk Management: Reflections on Capacity Building of Livelihoods Adaptation to Climate Change (Phase-II) in Bangladesh

Prepared by:
Atiq Kainan Ahmed

Project Implementing Partners:
Department of Agricultural Extension (DAE)
Food and Agriculture Organization of the United Nations (FAO)
Asian Disaster Preparedness Center (ADPC)

March, 2010

Submitted by:
Asian Disaster Preparedness Center (ADPC)
Bangkok, Thailand

Table of Content

List of Tables

List of Figures

Contributions:

This report is prepared by Atiq Kainan Ahmed taking various levels of inputs during course of the project from Dr Jayaraman Potty, Dr Abu Wali Raghib Hassan, Sanjib Saha, AR Subbiah and Dr Stephan Baas.

Chapter 1. Introduction

1.1 Background

The Livelihoods Adaptation to Climate Change Phase II (LACC II) project aims to introduce, improve or further strengthen disaster risk reduction and climate change adaptation capacities for sustainable livelihoods and food security in the rural sectors including crops, livestock, fisheries and forestry and other key factors of rural livelihoods in drought prone and coastal regions of Bangladesh.

Building on and using the human resources and capacities of several technical departments, the project, led by the Department of Agricultural Extension, will (i) further strengthen institutional and technical capacities for improved adaptation to climate variability and change at all relevant levels, addressing climate information needs, knowledge gaps, key skills and competencies, and technology needs, and (ii) implement in a participatory way and jointly with local communities good practices and strategies to effectively address climate variability and change, and related natural disasters.

1.2 ADPC support

Under the project, Asian Disaster Preparedness Center (ADPC) has provided support to the LACC II Project Management Unit (PMU) and DAE in building capacity of the local level professionals in climate change and livelihoods based climate change adaptive capacity in the agriculture sector. The ADPC input to the LACC-II project can be broadly indicated into following three different areas:

- Capacity building of DAE staffs, NTWIG members and project professionals in fundamentals of climate change and climate forecast applications
- Initiate and upgrade a proactive learning environment and working relationship among DAE and other national hydro- meteorological information source agencies; and
- Compile analysis of future climatic risk related information in the project situation assessment report for the coastal zone areas.

The present report will provide details of these activities as well as the gradual learning experiences from these areas where ADPC provided inputs to the overall LACC-II initiative.

1.3 Structure of the report

The present report is structured in following five chapters. In the Chapter 1m the project background and the ADPC support to the LACC-II project is outlined in an introductory manner.

The Chapter 2 talks about the contexts in a manner where reader can get information on what is likely to be changing in future in Bangladesh and in particular in the southern part of coastal pilot upazilas of LACC-II project.

The Chapter 3 provides a status description of various Climate Forecast Applications in Bangladesh and tries to situate where are we now?

In the Chapter 4, the ADPC inputs to the Capacity Building Experiences under the project is outlined in detailed manner.

The final Chapter of the documents the key reflections and recommendations emerged from the ADPC input and LACC-II capacity building experiences in general.

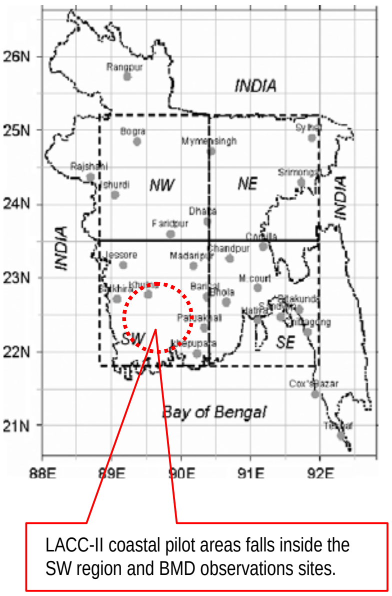
Chapter 2. What is likely to be changing in future?

The present Chapter provides a synoptic analysis of various types of future anticipated risks that are likely to make impacts in different timescales over the country in general and over the coastal areas of Bangladesh where the LACC-II pilot areas are situated. Data and information various secondary sources of related parameters with varied scales ranging from regional, national and sub-national scales are reviewed for framing up the future anticipated risks of the LACC-II project pilot areas.

There is a host of studies available that talks about the future and anticipated climatic risks of Bangladesh and the coastal zone in a generic manner but often these publications are very much based on a quite limited number of original research works. In the present Chapter, thereby, a focused concentration is given to a "core set only recently published original research works". Some of the data that are published from authentic sources are thereby used in this Chapter.

For understanding the patters of rainfall and temperature in future contexts the "Preparation of Look-up Table and generation of PRECIS scenarios for Bangladesh (November, 2008)" study report submitted by Bangladesh University of Engineering and Technology (BUET) is consulted with other relevant reports. This report is also published jointly from the Climate Change Cell (CCC), DoE. The UK IDS supported ORCHID report titled "Piloting Climate Risk Screening in DFID Bangladesh: Detailed Research Publication (IDS: April 2007) is also consulted for bringing some additional latest information.

The Sea Level Rise (SLR) and water salinity related information are adopted from a latest available (June 2007) study titled "Investigating the Impact of Relative Sea-Level Rise on Coastal Communities and their Livelihoods in Bangladesh" UK Department for Environment Food and Rural Affairs carried out by two lead Bangladesh government trust agencies: Institute of Water Modeling (IWM) and Center for Environment and Geographic Information Services (CEGIS).



2.1 Analysis of future anticipated risks

2.1.1 Rainfall and Temperature

The regional climate modeling system PRECIS (Providing REgional Climates for Impacts Studies) has recently been model run to project the rainfall and temperature situations for future. In a recent study carried by BUET (BUET, Nov. 2008) projections for rainfall and temperature in 2030, 2031, 2050, 2051, 2070 and 2071 has been generated using ECHAM4 SRES A2 emission scenarios as the model input. PRECIS model run has provided results for the whole country based on the BMD observation areas and region. The LACC-II project pilot upazilas fall under the Southwest Region (SW) from this grid thereby the results can justified for the pilot upazilas.

Rainfall

The PRECIS model sets a figure of 6.78 mm/d for the annual average rainfall in the baseline period (1961-1990) in the country. PRECIS model results indicate that the annual average rainfall in year 2030 will be 6.93 mm/d, in year 2050 it will be 6.84 mm/d, and 7.17 mm/d in the year 2070.

An important finding was that in Bangladesh, the average rainfall during monsoon and post-monsoon periods will increase whereas in dry season it will remain close to historical amount. Rainfall during the pre-monsoon period is anticipated to fluctuate in different years as well.

The PRECIS model outputs indicated that the monsoon rainfall will be increased in all years and from 2051 to onwards its surplus amount is large. It will remain almost same in 2030 and 2050. Importantly, large amount of rainfall is projected in August for all years except its deficit in 2030.

In terms of percentage of changes of rainfall from the observed baseline period, this is likely to increase about 4% (in 2030), 2.3% (in 2050) and 6.7 % (in 2070) in the country in general. Some of the model results are shown in the following table and in the model run scenarios.

Table 2-1. Summery of changes of rainfall (%) in the SW region (for LACC-II area) .

	2030					2050					2070				
	DJF	MAM	JJAS	ON	**Ann.**	DJF	MAM	JJAS	ON	**Ann.**	DJF	MAM	JJAS	ON	**Ann.**
SW	-3.6	-2.9	-5.5	19.8	**2.0**	-4.1	-6.3	-5.8	17.0	**0.2**	1.3	7.7	3.9	17.7	**7.6**
BD	-8.7	4.1	3.8	16.6	**4.0**	-4.7	-3.5	3.0	14.5	**2.3**	1.8	7.4	4.6	13.2	**6.7**

Source: Adapted from BUET (Nov.2008). **Note:** LACC-II coastal upazilas falls under SW region.

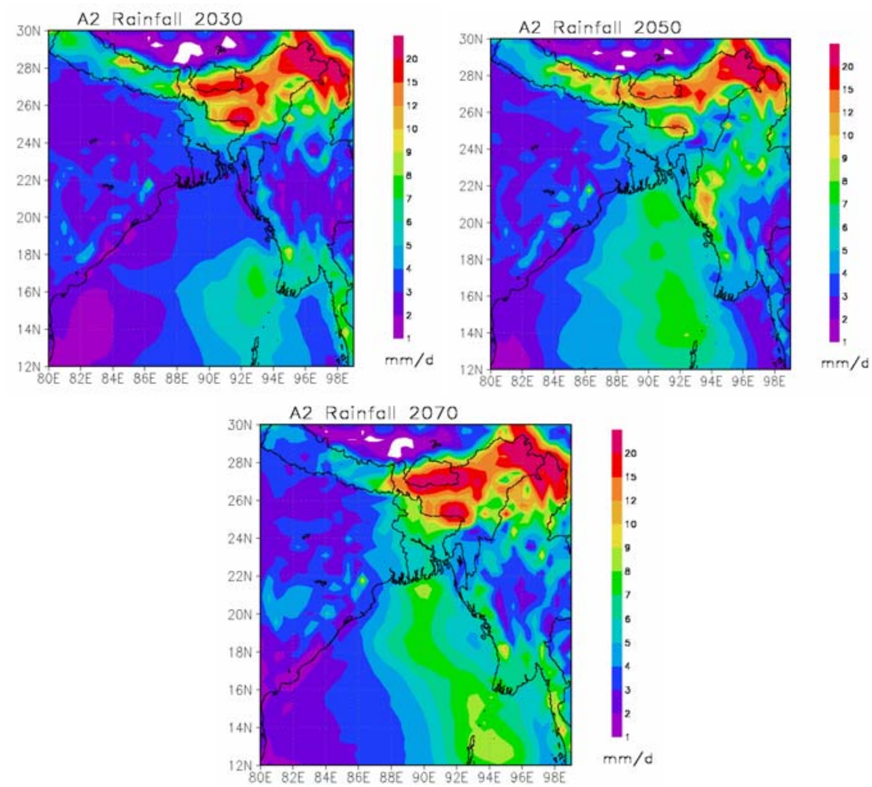


Figure 2-1. Three figures: A2 (SRES A2 Emission) rainfall scenarios generated by PRECIS in year 2030, 2050 and 2070. (Source: BUET, Nov. 2008).

Temperature

The monthly average maximum temperature in the country, as per the latest PRECIS model results, will change from -1.2°C (baseline year 1961-1990) to 4.7 °C in 2030, to 2.5 °C in 2050 and to 3.0 °C in 2070. Maximum temperature will increase during monsoon period and it will decrease in other periods.

On the other hand, monthly average minimum temperature will increase in all periods and vary from 0.3 to 2.4 °C in 2030, from 0.2 to 2.3 °C in 2050 and from -0.6 to 3.3 °C in 2070. Large increase of temperature is the clear indication of global warming. The observed period (year 1961-1990) was also considered as baseline for all temperature parameters under the PRECIS modeling.

The projected results for the maximum and minimum temperature (C) in various months, anticipated changes (%) in three projected years and in areas (BD compared with SW) are shown in comparison with the observed baseline period below. The model run scenarios for the maximum temperature in three future scenarios are also shown graphically.

Table 2-2. Projected maximum and minimum temperature (C) with observed values.

	Observed Temperature (C) in baseline period (1961-1990)		Projected Temperature (C)					
			2030		2050		2070	
	Max. temp.	Min. temp.	Max. temp.	Min. temp.	Max. temp.	Min. temp.	Max. temp.	Min. temp.
DJF	26.66	14.11	26.64	14.76	26.73	14.70	26.73	14.55
MAM	32.48	22.44	32.27	23.65	32.25	23.78	32.16	24.08
JJAS	31.16	24.44	32.45	27.22	32.05	27.48	32.18	27.67
ON	30.07	21.13	29.62	21.83	29.72	22.32	29.64	22.15
Annual	30.18	21.14	30.48	22.31	30.38	22.51	30.39	22.57

Source: Adapted from BUET (Nov.2008).

Table 2-3. Summery of changes of temperatures in SW region (for LACC-II area).

		2030					2050					2070				
		DJF	MAM	JJAS	ON	**Ann.**	DJF	MAM	JJAS	ON	**Ann.**	DJF	MAM	JJAS	ON	**Ann.**
Maximum Temperature Change (C)	**SW**	-0.12	0.09	0.30	-0.90	**-0.06**	-0.23	0.21	0.07	-0.95	**-0.14**	-0.35	0.06	0.26	-0.85	**-0.13**
	BD	-0.03	0.16	0.23	-0.52	**0.02**	-0.05	0.27	0.10	-0.44	**0.01**	-0.08	0.20	0.20	-0.50	**0.02**
Minimum Temperature Change (C)	**SW**	0.01	0.40	0.62	0.33	**0.36**	-0.25	0.35	0.76	0.90	**0.43**	-0.59	0.71	1.45	0.29	**0.56**
	BD	0.13	0.48	0.64	0.05	**0.37**	-0.03	0.52	0.74	0.44	**0.44**	-0.19	0.86	1.30	0.24	**0.64**

Source: Adapted from BUET (Nov.2008). **Note:** LACC-II coastal upazilas falls under SW region.

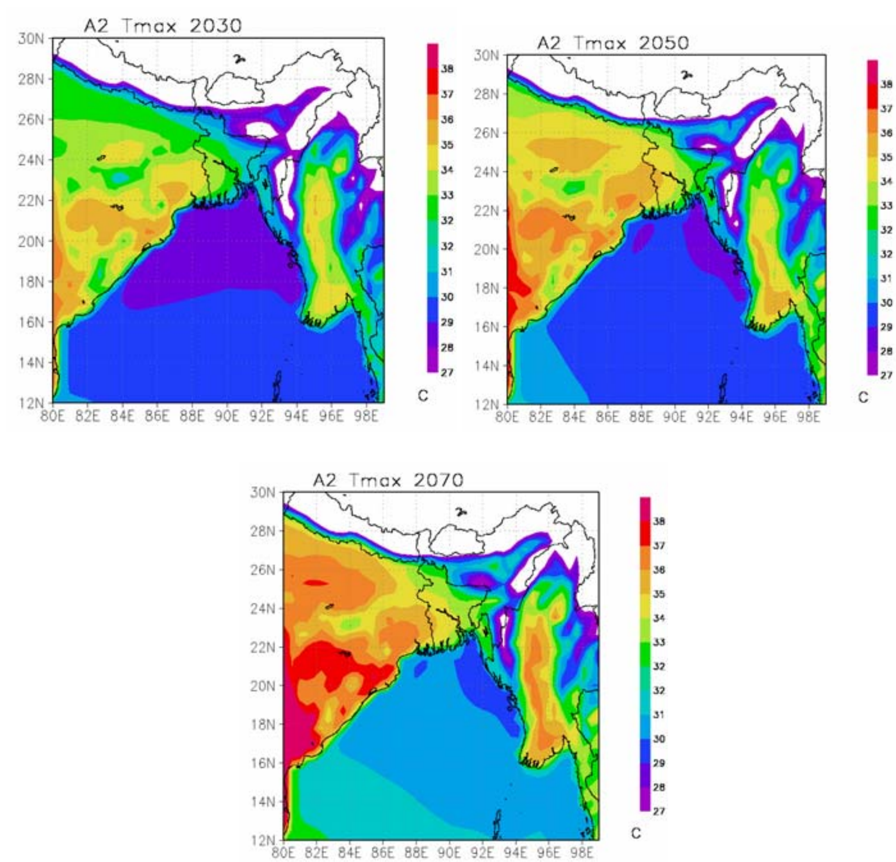


Figure 2-2. Three figures: A2 (SRES A2 Emission) maximum temperature scenarios generated by PRECIS in year 2030, 2050 and 2070 (Source: BUET, Nov. 2008).

One of the major conclusions came from the PRECIS results is that the variation of rainfall and temperature (maximum and minimum) in a location over Bangladesh and in a particular month is quite large than the seasonal or annual average. The following model result diagrams can be compared with the reference of the baseline period specified in the above table.

2.1.2 Sea Level Rise (SLR)

The threat of sea level rise spans an enormous range of possible impacts from the relatively small and manageable to the catastrophic in the country. Bangladesh coast has been identified as one amongst 27 countries, which are the most vulnerable to the impacts of global warming induced accelerated sea level rise.

In a study carried out by the UK Department for Environment Food and Rural Affairs (DEFRA, June 2007) has made a detailed assessment of the potential impacts of relative sea-level rise (resulting from global climate change, changes in river-flow and coastal development) on coastal populations, socio-economic impacts on livelihoods of coastal communities of Bangladesh. The study has considered the sea level rise, changes in intensity of cyclones and precipitation for both low (B1) and high (A2) greenhouse gas emission scenarios according to the 3rd IPCC predictions.

The study area covers the LACC-II project pilot areas and the conclusions are significant for the four pilot upazilas of the project. Some of the physical impacts of SLR identified for the Bangladesh coast are as follows:

Table 2-4. Projected Inundated Area (more than 30cm) in the coastal districts for different SLR.

District	Total Area (km^2)	Baseline year 2005 (km^2)	Inundation area for SLR (km^2)			
			2080 B1 [15cm]	2050 A2 [27cm]	2080 A2 [62cm]	2080 A2 [62cm+10%rainfall]
Khulna	4394	2137	2219	2380	2459	2465
Pirojpur	1308	735	858	940	1034	1071
All coastal districts	47194	17240	18685	19722	21839	22717

Source: Adapted from DEFRA (June, 2007)

Projected inundation results for the anticipated SLR 15cm (B1 scenario), 27cm (A2 scenario) and 62cm (A2 scenario) are shown in the following three maps. In all the scenarios, the LACC-II project pilot upazilas are likely to be inundated under the sea level rise.

DEFRA study results showed that about 13% more area (469,000 ha) will be inundated in monsoon due to 62cm sea level rise for high emission scenario A2 in addition to the inundated area in base condition (following Table). The most vulnerable areas are the areas without polders like Patuakhali, Pirojpur, Barisal, Jhalakati, Bagerhat, Narail. Due to increased rainfall in addition to 62cm sea level rise, the inundated area will be increased and about 16% (551,500 ha) more area will be inundated in the year 2080. On the contrary, in the dry season due to 62cm sea level rise about 364,200 ha (10%) more area will be inundated (inundation more than 30cm) for A2 scenario in the year 2080. However, 15cm sea level rise has insignificant impact on inundation in dry season.

Table 2-5. Area (Ha) to be inundated due to SLR in Monsoon and Dry Season in various year.

Scenarios	Monsoon Season		Dry Season	
	Inundated area, [ha]	Increase in inundation area, [ha]	Inundated area, [ha]	Increase in inundation area, [ha]
Base	1,720,200 [50%]		404,500 (12%)	-
B1, Yr 2080 (SLR 15cm)	1,863,600 [54%]	143,500 [4%]	Insignificant change	-
A2, Yr 2050 (SLR 27cm)	1,972,200 [57%]	252,000 [7%]	559,100 (16%)	154,600 [4%]
A2, Yr 2080 (SLR 62cm)	2,189,200 [63%]	469,000 [13%]	768,600 (22%)	364,200 [10%]
A2, Yr 2080 (SLR 62cm+10% rainfall)	2,271,700 [66%]	551,500 [16%]	Not Applicable	

Source: DEFRA, 2007.

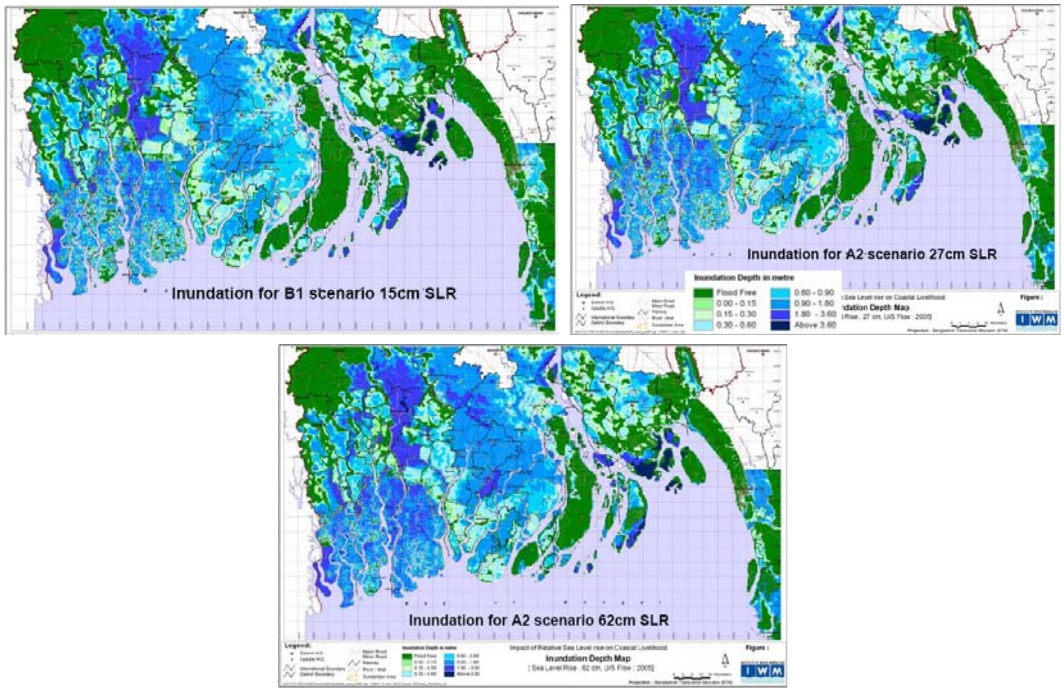


Figure 2-3. (three figures). Projected inundation for SLR 15cm (B1), 27cm (A2) and 62cm (A2) (Source: DEFRA, 2007).

Drainage congestion/water logging

About 25 polders (i.e. circular dykes that are constructed in the coastal areas in the 1960's to protect coastal areas from saline water and to reclaim for rice production) in the southwest region may experience severe drainage congestion due to 62 cm sea level rise and 13 polders embankment will be overtopped due to increased water level in the peripheral rivers. Due to the overtopping of the embankment about 120,200 ha of these polders will be deeply inundated (more than 60cm) whereas in base condition inundated area is only 42,200ha. About 32% more area will be deeply inundated due to overtopping of embankment. The LACC-II coastal upazilas are likely to face such drainage congestion and waterlogging in future situation.

Polder/dyke overtopping

Sea level rise and potentially higher storm surge is likely to result in over-topping of saline water behind the embankments of the polders. Modeling results fro IWM (under DEFRA study) shows that for 62cm sea level rise for A2 scenario shows that 13 polders may cause inundation due to overtopping of the embankments for 62 cm sea level rise, as shown in following Figure. Due to the overtopping of the embankment about 120,200 ha of these polders will be deeply inundated (more than 60cm) whereas in base condition inundated area is only 42,200ha. About 32% more area will be deeply inundated due to overtopping of embankment. Some of the LACC-II coastal upazilas fall into these potentially overtopped polders.

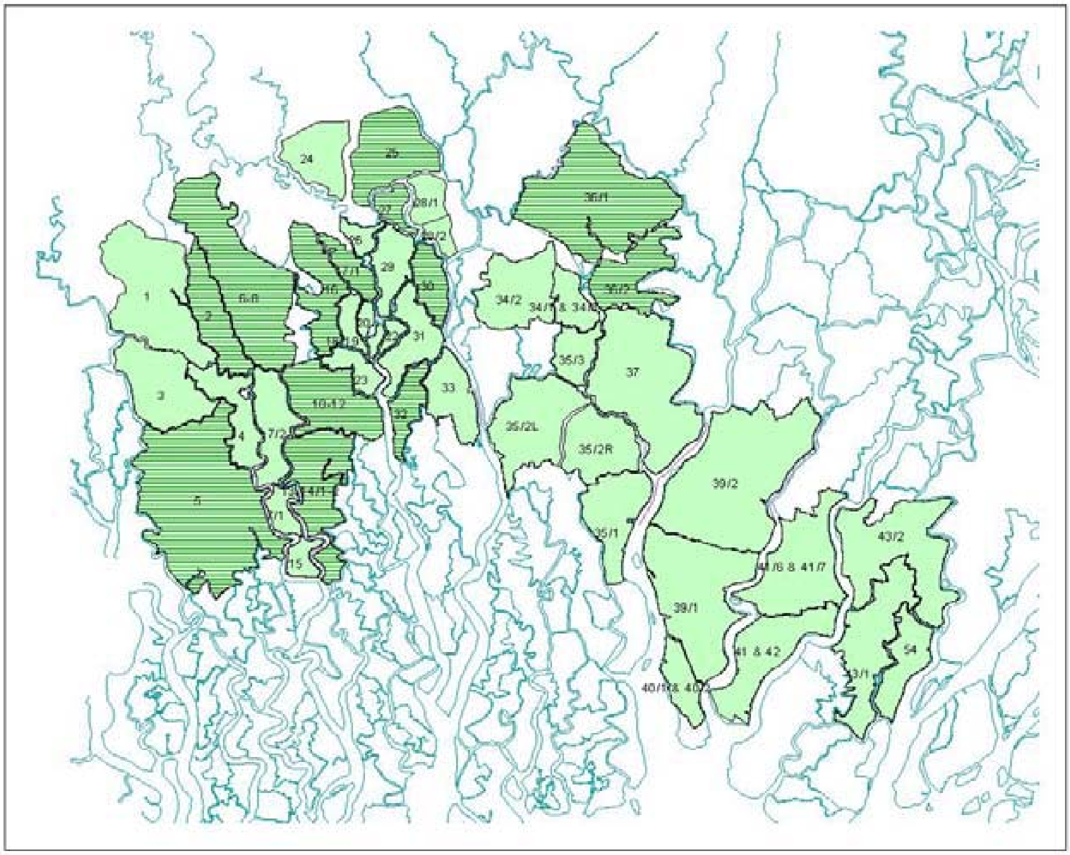


Figure 2-4. Projected Polder inundation due to embankment overtopping for A2 scenario 62cm SLR.

2.1.3 Water Salinity

As per the DEFRA (June, 2007) study, salinity is anticipated to intrude more landward specially during dry season due to sea level rise. Consequently brackish water area would increase and it is seen that sea level rise of 27 cm causes 6% increase of brackish water area compared to base condition. About an additional area of 327,700 ha would become high saline water zone (>5 ppt) during dry season due to 60 cm sea level rise. In the monsoon about 6% of sweet water area (276,700 ha) will be lost. Impact of 15cm sea level rise on salinity intrusion under low emission scenario B1 in the year 2080 is insignificant.

Table 2-6. Changes in fresh and brackish water area (Ha) in dry and monsoon.

Scenario	Dry season			Monsoon season		
	Fresh water area (<1 ppt)	Brackish water area (>1 ppt)	Change (%)	Fresh water area (<1 ppt)	Brackish water area (>1 ppt)	Change (%)
Base	2,562,500	2,152,000		3,779,600	9,403	
A2, 27cm [2050]	2,273,300	2,441,200	289,200[6%]	3,665,400	10,508	114,200[2%]
A2, 62cm [2080]	2,135,700	2,578,800	426,800[9%]	3,502,800	12,111	276,700[6%]

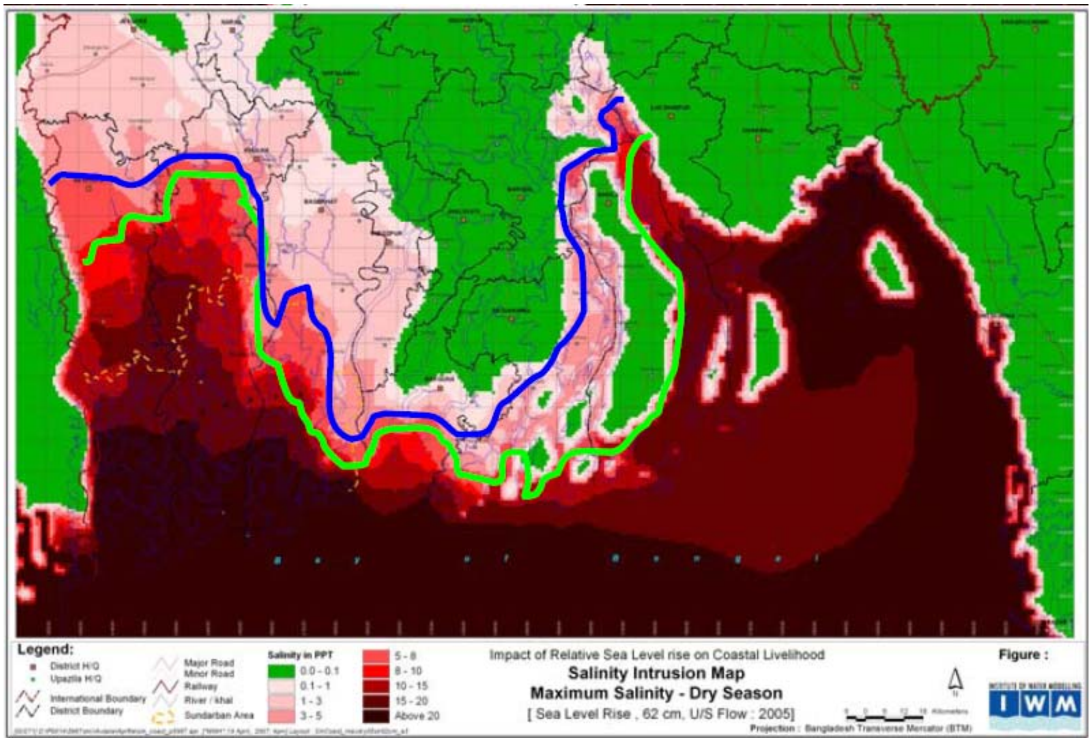


Figure 2-5. Maximum salinity intrusion in dry season for 62cm SLR; figure shows 5ppt saline front movement; green line for base condition (2005) & blue for 62cm SLR.
Source: DEFRA (June, 2007).

The above figure suggests that the LACC-II project upazilas under Khulna districts will be affected by salinity in the dry season quite heavily.

2.1.4 Changes in Storm Surge and Incursion

The IDS ORCHID study in 2007 has made an attempt to estimate future wind velocity and surge height for the Bangladesh coast following the above methods; empirical response functions between temperature and wind speed and wind speed and surge height.

The results show that increases in wind velocity range from 3% to 12% by the 2020s and from 4% to 20% by the 2050s. Storm surge heights increase from 15% to 25% (2020s) and 32% (2050s) due to increases in temperature. Changes in surge intrusion length (x in km), for different coastal zones of Bangladesh are also estimated in Table with the highest temperature changes for the 2020s and 2050s (i.e. worst case).

The LACC-II coastal pilot areas resides in the **Zone 5 (Barguna to Symnagar)** and shows storm surge intrusion length maximum of 43.38km in 2020 and 46.63km in SRES A2 Scenario and 40.01km and 45.20km in SRES B1 Scenario.

Table 2-7. The storm surge intrusion length (x in km), for different coastal zones of Bangladesh for Max. and Min. SRES A2 and B1 for 2020s and 2050s. (LACC-II pilot areas are under zone-5).

		Intrusion Length X (km)							
		SRES A2 Scenario				SRES B1 Scenario			
		2020s		2050s		2020s		2050s	
Coastal Zones	HRA	Max	Min	Max	Min	Max	Min	Max	Min
Zone 1 (Tecknaf to Cox's bazar)	3.00	3.47	3.32	3.72	3.45	3.55	3.42	3.61	3.42
Zone 2 (Cox's bazar to Chittagong)	6.50	9.14	8.73	9.86	9.09	9.39	9.00	9.54	9.00
Zone 3 (Chittagong to Noakhali-Bhola)	20.00	30.72	29.31	33.17	30.53	31.55	30.24	32.09	30.23
Zone 4 (Bhola to Barguna)	31.00	38.91	37.19	41.91	38.67	39.94	38.33	40.59	38.31
Zone 5 (Barguna to Symnagar)	39.00	43.38	41.52	46.63	43.13	40.01	38.21	45.20	42.73

Source: IDS (April, 2007).

The study also showed that (following figure) that the existing cyclone High Risk Area (HRA) moves further inland with the distance varying between zones according to their physical characteristics. Increases in the wind velocity and storm surge height result in greater inland intrusion and an increase in the area exposed to cyclone hazard. The HRA increase to 35% and 40% in the 2020 and 2050 respectively. The LACC-II project coastal pilot upazilas also reside in this and will face the similar risk.

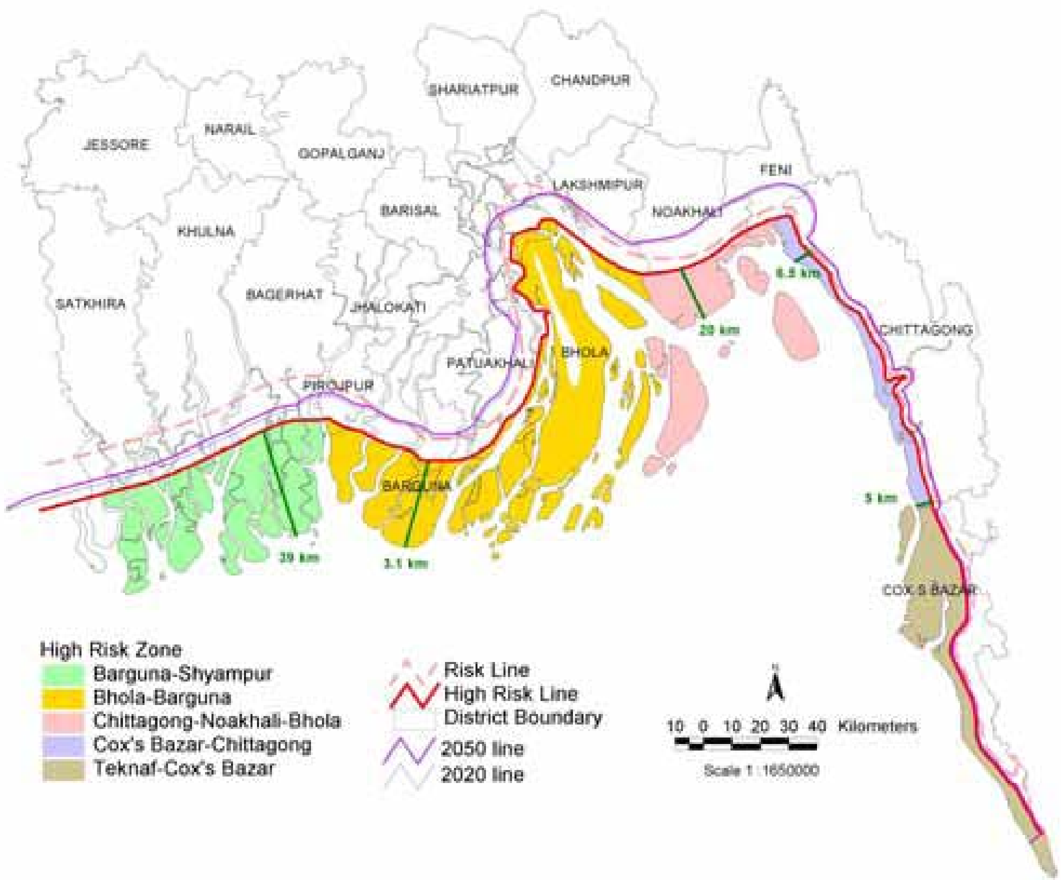


Figure 2-6. Changes in cyclone High Risk Areas for current conditions, the 2020s and the 2050s. Only worst case examples included – highest warming.
Source: IDS (April, 2007).

Table 2-8. A summary of key climatic parameters and anticipaed changes at national level.

Climate parameter	Future climate scenarios	Confidence in projection
Increasing temperatures	Warmer in all seasons. Higher average temperatures likely to be associated with increase in extreme high temperatures.	High confidence, good agreement between climate models.
Change in rainfall amounts/ distribution	Seasonal differences: tendency for wetter monsoon (JJA), drier dry seasons (DJF) Changes in the upstream basin region and Bangladesh broadly similar.	Medium confidence, less agreement between climate models on direction and magnitude of change. Need to consider a range of outcomes: dry, average and wet (modest average changes, wide range between dry and wet).
Changing rainfall intensities	Most models indicate wetter monsoon conditions. Likely to be associated with higher rainfall intensities causing higher peak flows in rivers and increases in flood magnitude/frequency. No clear signal of changes in variability in monsoon rainfall.	Medium confidence.
Droughts	Given reductions in mean dry season rainfall it is likely that dry spells may increase/lengthen with negative consequences for water availability/soil moisture. Higher temperatures will contribute to increased evaporation losses, likely to worsen soil moisture deficits.	As for rainfall above. Likely to be a problem in areas already affected by drought. Medium confidence.
Cyclone and Storm surge	Inconclusive – IPCC 2001 concluded that '…there is some evidence that regional frequencies of tropical cyclones may change but none that their locations will change. There is also evidence that the peak intensity may increase by 5% and 10% precipitation rates may increase by 20-30%.'	Low confidence, evidence points towards some increase in frequency/intensity.
Sea level rise (including sedimentation and subsidence effects)	IPCC ranges; 2030s; 4.5 – 23cm (14cm used by NAPA3) 2050s; 6.5 – 44cm (32cm used by NAPA)	High confidence, but wide range in estimates, depending on emission scenario and scientific uncertainties. Regional/local situation also important.

Source: Adopted from IDS (April, 2007).

2.2 Uncertainties in prediction and downscaling

As indicated in the beginning of the chapter this the scope of this analysis is to come up with generic indications of the future anticipated risks that will impact the country as well as the LACC-II project pilot areas in the coastal zone. In this regard, the core and latest research findings are looked at and presented briefly in this chapter. However, in reviewing and findings information for the location specific risk information it was found that the PRECIS model results are primarily developed based on the BMD observation areas and their operational regions where they have climatic station data.

The LACC-II project pilot upazilas fall under the Southwest Region (SW) from this grid thereby the results for SW are connoted for the LACC-II pilot project areas. Independent analysis for the LACC-II upazilas is quite difficult at this point using the existing model run results such as PRECIS. At this point, very little historical data is available that can allow comprehensive climate modeling for the LACC-II project upazilas. Thereby keeping these limitations in mind the attempt has been made to synergize analytical connotations or references for the LACC-II project areas. However, the upazila based analysis on the following chapter may also give some local specific indications.

The PRECIS and other model results allow coming up with some indication for the region but as they have also indicated in their report that the climatic variables are complicated variables and the model run parameters are limited as well. In this line, few set of limitations can be identified:

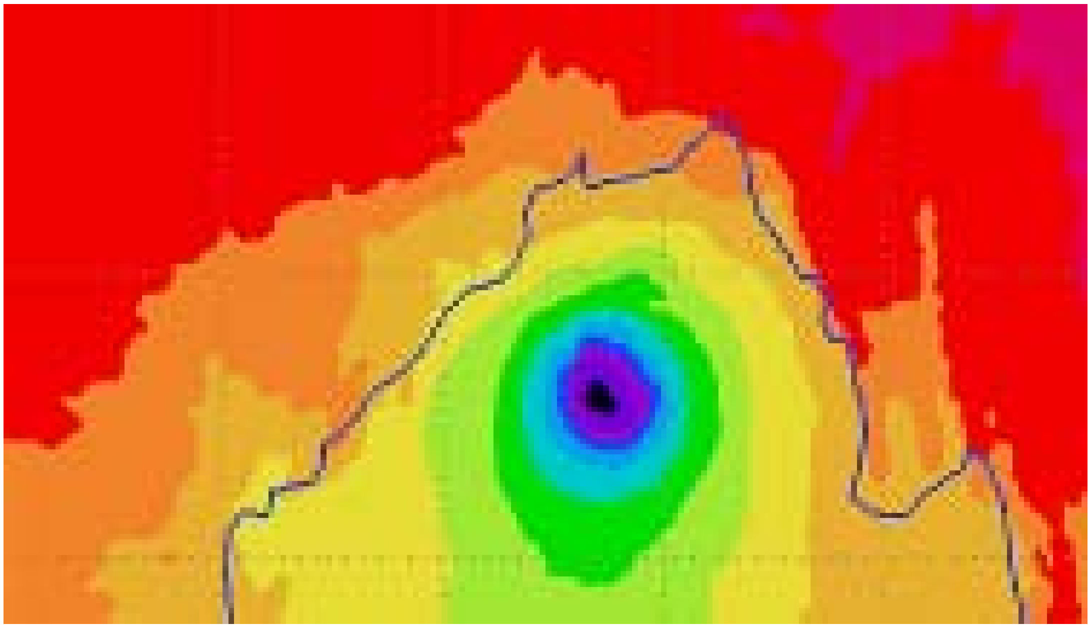
a) location specific limitations;
b) modeling uncertainties; and
c) data reliability.

Considering these above areas of limitations, the model results presented in this chapter brings some synergic information which might be useful for futuristic policy making in agricultural and allied sectors. However, the operational uses, these information and results can only provide a guidance which can lead to general adaptation strategy development. This perhaps one of the reasons for scoping future concrete participatory and technical climate change related assessment at local level. In this respect, more downscaled analysis of climate change situations should accommodate and build on what local level data is available and making innovative attempt of livelihoods based participatory analysis.

One issue needs to be kept in mind that from the national level climatic model run results one cannot anticipate all the local or location specific risks since the location specific differences are quite large at the same time the downscaled with appropriate scale model results are just not available with adequate accuracy. For operational recommendation making and framing livelihoods adaptation, however, both the sets of exercises: a) modeling of future risks; and b) the continued analysis of the present situation should be used in a mutually inclusive manner.

This should be seen rather as a two-streams of the same endeavor where “technical downscaling” of climatic risk analysis should improve better and the “gradual up-scaling” of local participatory risk assessments will shape up to inform the adaptation preferences and dynamic situations. It was found during the project that initiation of an “adaptive learning” process and “adaptive capacity development” are at this point for overall climate risk management in agriculture sector.

Chapter 3. Climate Forecast Applications: where are we now?



The present Chapter providing a technical review of the Climate Forecast Applications (CFA) vis-à-vis early Warning Systems (EWS) of the existing for hydro- metrological hazards in Bangladesh attempts to inform on where we the country situation seats now. Review of predominant climatic hazards are only included here and informs on respective status of prediction methods, forecasting, preparedness measures etc. For situating better with the LACC-II perspective, these are discussed both in terms of national level developments as well as bringing local level promising initiatives.

3.1 National level developments

3.1.1 Bangladesh Meteorological Department (BMD)

Different types of information for climate forecasting and early warnings issued by Bangladesh Meteorological Department (BMD) are tropical cyclone warning, Nor'wester warning, heavy rainfall warning, squall warning, heat wave warning, cold wave warning, fog warning and agro-climatological predictions. BMD, under the ministry of Defense collects data through it own radar observation stations, Microwave and VSAT link. Then they firstly generates or disseminates data FFWC and then president's office and prime minister's office and then electronic media, print media, different organizations, ports, air force, Navy and Army along with MoFDM and finally they disseminate to other ministries, GOs, NGOs and related interested party including media through the DMB and government channels.

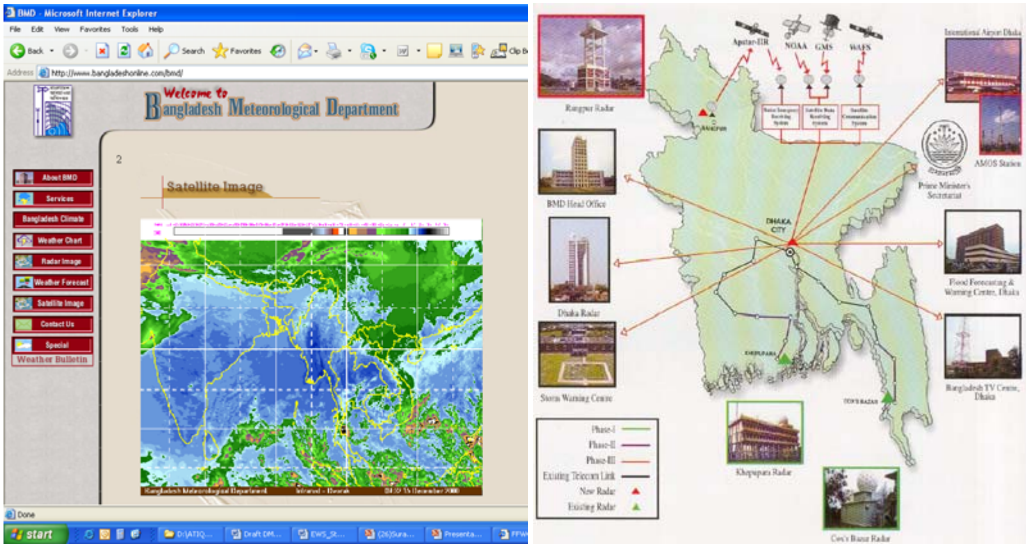


Figure 3-1. BMD Website.
Source: http://www.bangladeshonline.com/bmd/

BMD is using 35 source observation stations, 10 pilot balloons, 3 rawinsande, 12 Agromet, 4 radar station observatories. Recently the BMD has set up 4 seismic observatories for earthquake related data collection and monitoring. But observatories among of that 4 is not in operation. Only one Chittagong observatory station is in operation.

To provide weather forecasts for public, farmers, mariners and aviators on routine basis and also to issue warning for severe weather phenomena such as tropical cyclones, Tornados, nor wasters, heavy rainfall heat and cold waves warnings. The BMD exchange meteorological data, forecasts and warnings to meet national and international requirements. This institution also provides meteorological data, radar echoes and satellite imageries and weather forecast for flood and storm warning centre at Dhaka and Rajshahi divisions. There are geophysical and metrological centre at Chittagong, Sylhet, Barishal and Khulna divisions.

Global Telecommunication system is being used for data information speed only 2400 bps only where normally broad band internet speed is now running on 240 kbps. Daily weather forecast products are being delivered to the media and around over 22 line agencies, ministries and departments.

3.1.2 Flood Forecasting and Warning Centre (FFWC)

The Early Warning System for floods in Bangladesh was gradually developed from the flood forecasting initiative of Bangladesh Water Development Board's (BWDB) Flood Forecasting and Warning Centre (FFWC). FFWC was established in 1972, and, since then, FFWC developed a comprehensive system of collecting and processing hydrologic and other data as input to forecasting models; preparing flood forecasts and warnings on a daily basis and disseminating the forecasts and warnings to a range of government and non-government organizations, media groups and other interested parties. Recent development of the Flood EWS, including the preparation of flood forecasting and warnings, has been supported several projects including:

- Consolidation and Strengthening of Flood Forecasting and Warning Services (CSFFWS)
- Environmental Monitoring and Information Network (EMIN)
- Community Flood Information Systems (CFIS)
- Climate Forecast Applications in Bangladesh (CFAB) Phase I and II, and
- Development of Regional, Basin Flood Forecast Model for use in Bangladesh

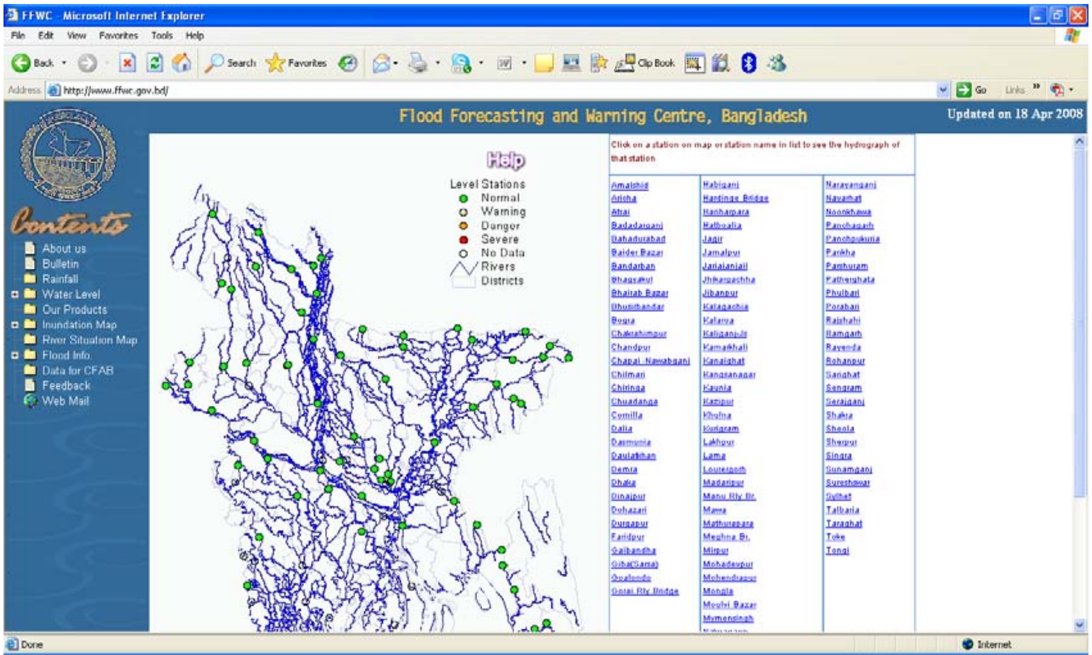


Figure 3-2. FFWC Website that updates daily flood forecast information.
Source: http://www.ffwc.gov.bd/

Flood forecasting models of FFWC developed on MIKE 11, one-dimensional modeling software used for the simulation of water levels and discharges in the rivers. For real-time flood forecasting, FFWC uses Flood Watch, a decision support system developed in ArcView GIS, which integrates database, modeling system, model outputs and dissemination of forecasts. FFWC as part of the BWDB is responsible for flood forecasting and its dissemination within Bangladesh.

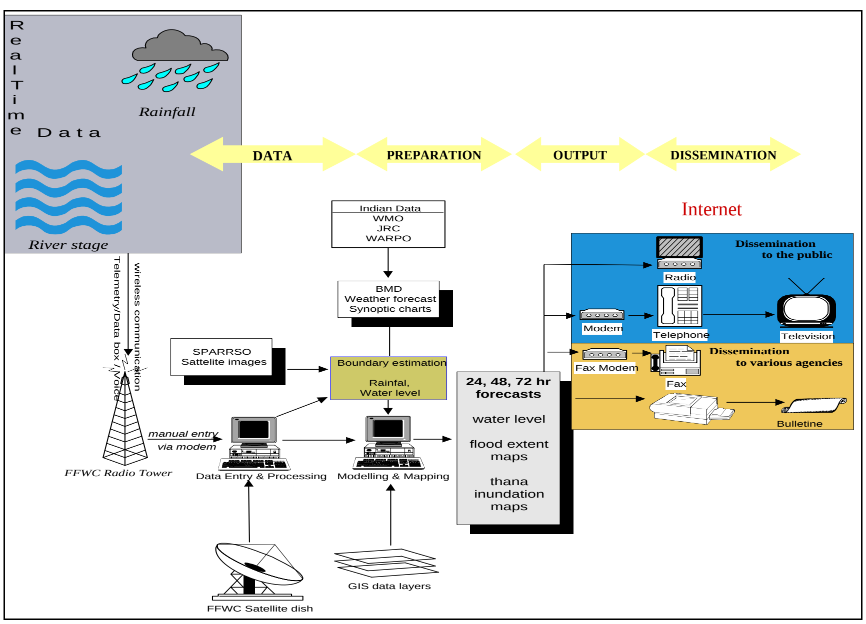


Figure 3-3. FFWC operational system network.

The warning information is disseminated through FFWC's traditional dissemination process (Fax, Telephone, e-mail). The overall warning generation and dissemination process has shown in the above diagram. FFWC receives rainfall data mainly from BMD. They have also arrangements with Indian Meteorology Department, Nepal Hydrology, Centre Water Level Commission, and China Bureau of Hydrology to receive rainfall and other water relevant information. FFWC receives raw data from these agencies and sixty-four FFWC's own stations and after processing the data they disseminate warning message at first all the Ministry and then DMIC, NDMC, DDMC, UDMC and all other organizations relevant to disaster management by Fax and e-mail. On the other hand IWFM, CEGIS, IWM, GSB are also involved in prediction of Flood area, Flood zoning map, Flood vulnerability. FFWC is responsible for monitoring flooding in a unified and multipurpose manner. FFWCs forecasting stations generate 24, 48 and 72 hour forecasts everyday.

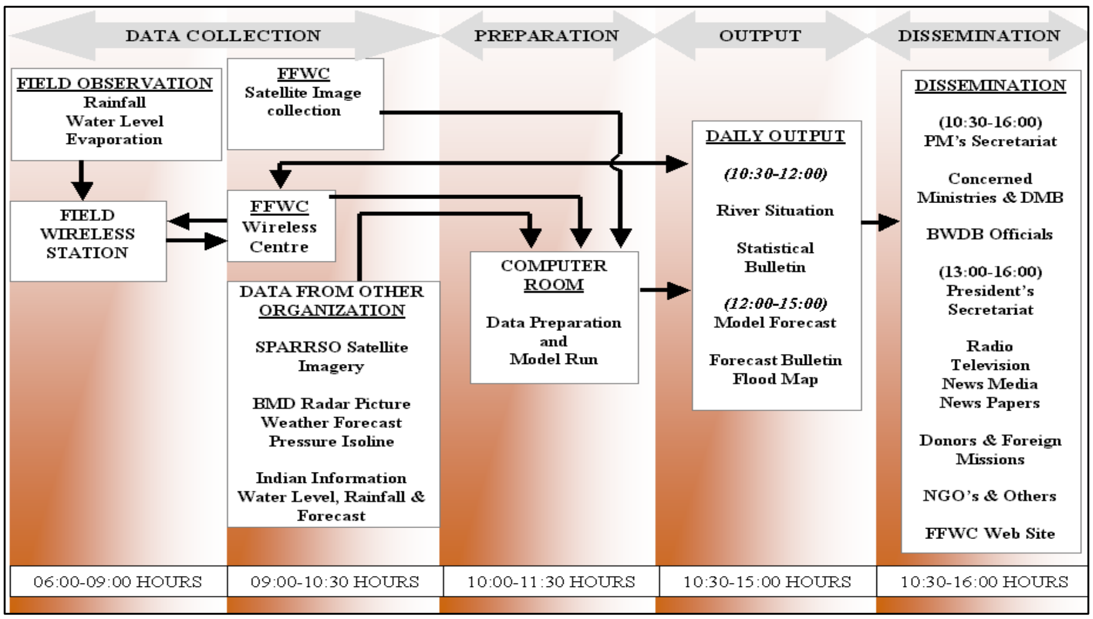


Figure 3-4. FFWC daily activity flow chart.

A daily bulletin, based on observed data and results of forecast models, is prepared, and distributed by FFWC at around 12:00 noon to various administrative tiers. The detailed daily activity for that information is shown in the above figure. The bulletin, mostly in tabular form, include the following:

a) a cover page showing geographical, environmental settings of Bangladesh and location of all monitoring stations;
b) river stage of all monitoring stations with respect to danger level, followed by rise/fall of water level on the respective date;
c) rainfall situation for a specific date, followed by monthly normal and cumulative rainfall;
d) summary of rainfall and river situation based on major findings;
e) 24- and 48-hour forecasts for some important stations affected by shallow, moderate, and severe flooding;
f) flood warning messages that display trends of water levels (if close to or exceeds the danger levels, at which flooding becomes a serious threat); and
g) a detail statistics on river stage and rainfall for three consecutive days.

Some of the products that FFWC shares through their regular and emergency network (shown in Table below) are shown in the following section:

Figure 3-5. Existing Flood Warning Product Dissemination Routes.

Dissemination Medium	FFWC Product	Recipient Group
Hard Copy (hand delivered), Fax and Email	Bulletins	Prime Minister's Office, government ministries, BWDB officials, government organizations
Fax and/or Email only	Bulletins	DMB, DMIC-CDMP, NGO's, embassies, international donor and aid organizations, news media
Internet	Bulletins, plots, flood map, Thana status	General public, international

Some of the regular outputs they share are as follows (as samples):

Output-1. A sample FFWC regular flood bulletin – "River Situation" (2 page bulleting in this respective date)

RIVER SITUATION AS ON 24-04-2008 AT 06:00 HOURS

SL	RIVER	STATION NAME	RHWL (m)	D.L. (m)	WATER LEVEL 23-04-2008	WATER LEVEL 24-04-2008	+ Rise - Fall in cm	Abov D.L in c
	BRAHMAPUTRA BASIN							
1	DHARLA	KURIGRAM	27.52	26.50	22.66	22.84	+ 18	
2	TEESTA	DALIA	52.97	52.25	50.50	50.30	-20	
3	TEESTA	KAUNIA	30.52	30.00	26.84	26.85	+ 1	
4	JAMUNESWARI	BADARGANJ	32.92	32.16	27.94	27.93	-1	
5	GHAGOT	GAIBANDHA	22.81	21.70	16.77	16.77	0	
6	KARATOA	CHAKRAHIMPUR	21.41	20.15	15.77	15.77	-1	
7	KARATOA	BOGRA	17.45	16.32	10.84	10.84	0	
8	BRAHMAPUTRA	NOONKHAWA	28.10	27.25	21.80	21.90	+ 10	
9	BRAHMAPUTRA	CHILMARI	25.06	24.00	18.79	18.91	+ 12	
10	JAMUNA	BAHADURABAD	20.62	19.50	14.50	14.54	+ 4	
11	JAMUNA	SERAJGANJ	15.12	13.75	8.31	8.40	+ 9	
12	JAMUNA	ARICHA	10.76	9.40	3.57	3.64	+ 7	
13	OLD BRAHMAPUTRA	JAMALPUR	18.00	17.00	11.33	11.31	-2	
14	OLD BRAHMAPUTRA	MYMENSINGH	13.71	12.50	5.71	5.71	0	
15	BURIGANGA	DHAKA	7.58	6.00	1.51	1.52	+ 1	
16	BALU	DEMRA	7.13	5.75	1.79	1.87	+ 8	
17	LAKHYA	NARAYANGANJ	6.93	5.50	1.85	1.83	-2	
18	TURAG	MIRPUR	8.35	5.94	1.91	1.91	0	
19	TONGI KHAL	TONGI	7.84	6.08	3.11	3.57	+ 46	
20	KALIGANGA	TARAGHAT	10.21	8.38	1.97	1.95	-2	
21	DHALESWARI	REKABI BASAR	7.66	5.18	1.65	1.63	-2	
22	BANSHI	NAYARHAT	8.39	7.32	1.79	1.78	-1	
	GANGES BASIN							
23	KARATOA	PANCHAGARH	72.65	70.75	67.53	67.53	0	
24	PUNARBHABA	DINAJPUR	34.40	33.50	27.96	27.96	0	
25	ICH-JAMUNA	PHULBARI	-	-	25.64	25.63	-1	
26	MOHANANDA	ROHANPUR	23.83	22.00	12.34	12.32	-2	
27	MOHANANDA	CHAPAI-NAWABGANJ	23.01	21.00	12.10	12.09	-1	
28	LITTLE JAMUNA	NAOGAON	16.20	15.24	5.27	5.27	0	
29	ATRAI	MOHADEBPUR	19.89	18.59	12.78	12.78	0	
30	GANGES	PANKHA	24.14	21.50	14.21	14.22	+ 1	
31	GANGES	RAJSHAHI	20.00	18.50	8.30	8.55	+ 25	
32	GANGES	HARDINGE BRIDGE	15.19	14.25	5.40	5.66	+ 26	
33	PADMA	GOALUNDO	10.21	8.50	3.02	3.06	+ 4	
34	PADMA	BHAGYAKUL	7.58	6.00	2.12	2.17	+ 5	
35	GORAI	GORAI RLY BRIDGE	13.65	12.75	4.32	4.32	0	
36	KUMAR	FARIDPUR	8.76	7.50	1.11	1.10	-1	

Cont/2

Page-2

SL	RIVER	STATION NAME	RHWL (m)	D.L. (m)	WATER LEVEL 23-04-2008	WATER LEVEL 24-04-2008	+ Rise - Fall in cm	Above D.L. in cm
	MEGHNA BASIN							
37	SURMA	KANAIGHAT	15.26	13.20	5.04	4.98	-6	
38	SURMA	SYLHET	12.44	11.25	3.65	3.45	-20	
39	SURMA	SUNAMGANJ	9.75	8.25	3.35	3.20	-15	
40	KUSHIYARA	AMALSHID	18.28	15.85	6.70	6.61	-9	
41	KUSHIYARA	SHEOLA	14.46	13.50	5.24	5.13	-11	
42	MANU	MANU RLY BR.	20.42	18.00	13.68	13.67	-1	
43	MANU	MOULVI BASAR	13.25	11.75	6.38	6.38	0	
44	KHOWAI	HABIGANJ	11.93	9.50	6.12	6.09	-3	
45	BHUGAI	NAKUAGAON	26.01	25.00	19.50	19.51	+ 1	
46	SOMESWARI	DURGAPUR	15.20	13.00	10.73	10.71	-2	
47	KANGSHA	JARIAJANJAIL	13.37	9.75	5.10	5.01	-9	
48	MEGHNA	BHAIRAB BASAR	7.66	6.25	2.08	2.06	-2	
49	GUMTI	COMILLA	13.56	11.75	6.99	6.82	-17	
50	GUMTI	DEBIDDAR	-	-	3.03	2.54	-49	
51	MEGHNA	*CHANDPUR L.W.L.	-	4.00	1.00**	0.95**	-5	
		*CHANDPUR H.W.L.	5.35	-	1.85***	1.80***	-5	
	SOUTH EASTERN HILL BASIN							
52	MUHURI	PARSHURAM	16.33	13.00	9.87	9.85	-2	
53	HALDA	NARAYAN HAT	18.05	15.25	11.90	11.90	0	
54	HALDA	PANCHPUKURIA	11.55	9.50	3.35	3.37	+ 2	
55	SANGU	BANDARBAN	20.38	15.25	4.80	4.80	0	
56	MATAMUHURI	LAMA	15.46	12.25	6.32	6.32	0	
57	FENI	RAMGARH	21.42	17.37	12.48	12.48	0	

NOTE: WATER LEVEL AT STATION ABOVE DANGER LEVEL UNDERLINED.
- DATA NOT AVAILABLE

L.W.L.: Lowest Water Level.
RHWL: Recorded Highest Water Level.
D.L.: Danger Level.
* : Tidal Station
** : Low Water Level of the Previous Day
*** : High Water Level of the Previous Day

DUTY OFFICER,
FLOOD INFORMATION CENTER,
BWDB, DHAKA.

Danger level:
Danger level at a river location is the level above which it is likely that the flood may cause damages to nearby crops and homesteads. In a river having no embankment, danger level is about annual average flood level. In an embanked river, danger level is fixed slightly below design flood level of the embankment.

Output-2. A sample FFWC regular flood bulletin – "Rainfall Situation" (2 page bulleting in this respective date).

RAINFALL SITUATION AS ON 24-04-2008 (IN MM)

SL NO	STATION	MAXIMUM FOR APRIL	NORMAL FOR APRIL	RAINFALL FOR 2008 22-04	23-04	24-04	TOTAL UPTODATE (UPTO 24-04-2008)
	BRAHMAPUTRA BASIN						
1	KURIGRAM	282.5	119.2	0.0	0.0	0.0	88.8
2	DALIA	242.4	102.1	0.0	0.0	0.0	30.0
3	KAUNIA	332.5	113.3	0.0	0.0	0.0	93.0
4	RANGPUR	189.9	164.8	0.0	0.0	0.0	49.8
5	CHILMARI	315.5	116.8	0.0	0.0	0.0	73.5
6	DEWANGANJ	434.3	129.0	0.0	0.0	0.0	23.0
7	GAIBANDHA	0.0	101.7	0.0	0.0	0.0	0.0
8	SERAJGANJ	314.8	110.9	0.0	0.0	0.0	30.0
9	BOGRA	242.6	89.4	0.0	0.0	0.0	8.5
10	JAMALPUR	345.8	116.4	0.0	0.0	0.0	38.5
11	MYMENSINGH	346.2	145.3	0.0	0.0	0.0	28.7
12	DHAKA	318.0	159.1	0.0	0.0	0.0	76.3
13	TANGAIL	267.7	112.7	0.0	0.0	0.0	11.7
	GANGES BASIN						
14	PANCHAGARH	172.8	68.6	0.0	-	0.0	50.2
15	DINAJPUR	188.5	69.9	0.0	0.0	0.0	15.7
16	PABNA	-	76.0	0.0	0.0	-	9.0
17	NAOGAON	378.5	69.9	0.0	-	0.0	20.3
18	MOHADEBPUR	-	-	0.0	0.0	0.0	0.0
19	KUSHTIA	250.8	83.0	0.0	0.0	0.0	23.1
20	RAJSHAHI	227.2	59.3	0.0	0.0	0.0	25.0
21	ROHANPUR	-	-	-	-	-	0.0
22	C.NAWABGANJ	-	-	0.0	0.0	0.0	41.9
23	JESSORE	329.9	82.7	0.0	0.0	0.0	29.5
24	KHULNA	276.0	87.2	0.0	0.0	-	13.0
25	SATKHIRA	326.3	93.0	0.0	0.0	0.0	94.2
26	FARIDPUR	483.1	517.7	0.0	0.0	0.0	32.5
27	MADARIPUR	0.0	0.0	-	-	-	0.0
28	BARISAL	311.5	105.0	0.0	0.0	-	1.0
29	PATUAKHALI	306.7	109.8	0.0	0.0	0.0	2.0
30	BARGUNA	-	-	0.0	0.0	0.0	32.2
	MEGHNA BASIN						
31	KANAIGHAT	1096.0	457.0	0.0	0.0	0.0	131.0
32	SYLHET	928.9	386.5	0.0	0.0	0.0	142.0
33	SUNAMGANJ	0.0	287.0	0.0	0.0	0.0	225.0
34	SHEOLA	994.7	403.7	0.0	0.0	0.0	158.0
35	MOULVI BAZAR	0.0	263.0	0.0	0.0	0.0	10.0
36	MANU RLY BR	0.0	262.8	0.0	0.0	0.0	20.0
37	HABIGANJ	0.0	228.2	0.0	0.0	0.0	14.1
38	SHERPUR	-	-	0.0	0.0	0.0	46.0
39	DURGAPUR	0.0	160.0	0.0	0.0	0.0	75.9
40	LORERGARH	-	-	0.0	0.0	0.0	173.0
41	NAKUAGAON	-	-	0.0	0.0	0.0	27.0
42	JARIAJANJAIL	-	-	0.0	0.0	0.0	38.0
43	BHAIRAB BAZAR	388.8	167.7	0.0	0.0	0.0	28.0
44	COMILLA	571.3	182.5	0.0	0.0	0.0	23.7
45	CHANDPUR	0.0	144.7	0.0	0.0	0.0	2.0

cont/2

Page-2

SL NO	STATION	MAXIMUM FOR APRIL	NORMAL FOR APRIL	RAINFALL FOR 2008 22-04	23-04	24-04	TOTAL UPTODATE (UPTO 24-04-2008)
	SOUTH EASTERN HILL BASIN						
46	PARSHURAM	561.9	166.9	0.0	0.0	0.0	34.3
47	NARAYANHAT	172.8	68.6	0.0	0.0	0.0	2.0
48	NOAKHALI	0.0	156.0	0.0	0.0	0.0	2.0
49	PANCHPUKURIA	0.0	147.0	0.0	0.0	0.0	0.0
50	BANDARBAN	786.0	161.7	0.0	0.0	0.0	0.0
51	RANGAMATI	0.0	119.0	0.0	0.0	0.0	0.0
52	LAMA	0.0	109.0	0.0	0.0	-	0.0
53	CHITTAGONG	0.0	152.0	0.0	0.0	0.0	0.0
54	RAMGARH	0.0	119.0	0.0	0.0	-	15.0
55	COX'S BAZAR	0.0	81.0	0.0	0.0	0.0	0.0
56	TEKNAF	-	-	0.0	-	-	-

NOTE: RAINFALL AT STATIONS ABOVE 50 MM UNDERLINED.
- DATA NOT AVAILABLE

In General, 50 mm or above rainfall in one day causes stress on local drainage system leading to localised flood.

300 mm or more rainfall in consecutive 10 days impedes the drainage and likely to cause rain-fed flood in the area.

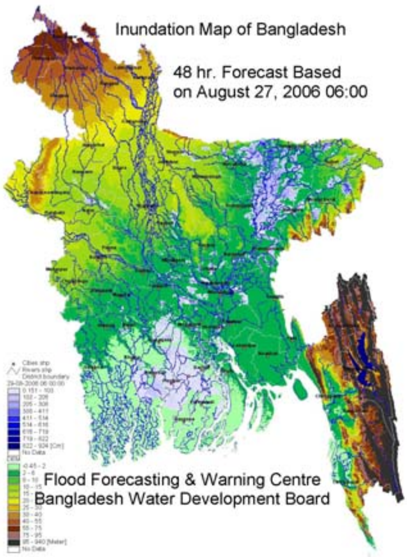
DUTY OFFICER
FLOOD INFORMATION CENTER
BWDB, DHAKA

Output-3. Is a 10-day Water Level Forecasts on the Major Rivers of Bangladesh. This is an additional forecasting beyond the traditional 24-48-72 hours and comes from the CFAB-FFS Model using Climate Forecast Applications in Bangladesh (CFAB) prediction data.

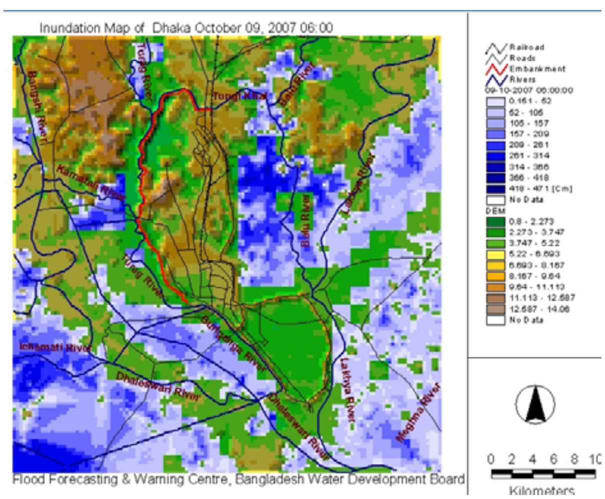
Forecast made on: 24-06-2007

Water Level in [m]			today	1-day fore-cast	2-day fore-cast	3-day fore-cast	4-day fore-cast	5-day fore-cast	6-day fore-cast	7-day fore-cast	8-day fore-cast	9-day fore-cast	10-day fore-cast	Forecast type
			24-06	25-06	26-06	27-06	28-06	29-06	30-06	01-07	02-07	03-07	04-07	
River	Station	D.L	0600	0600	0600	0600	0600	0600	0600	0600	0600	0600	0600	
Jamuna	Serajganj	13.75	13.50	13.57	13.67	13.85	13.95	13.90	13.93	13.92	13.65	13.52	13.63	Upper Range
				13.50	13.38	13.30	13.28	13.23	12.99	12.91	12.82	12.72	12.69	Lower Range
				13.55	13.54	13.60	13.77	13.74	13.50	13.40	13.24	13.10	13.15	Mean
Jamuna	Aricha	9.40	8.52	8.57	8.53	8.76	9.02	9.02	9.01	9.08	8.95	8.80	8.83	Upper Range
				8.55	8.41	8.42	8.41	8.35	8.24	8.14	8.09	8.05	8.07	Lower Range
				8.56	8.48	8.58	8.71	8.73	8.59	8.48	8.40	8.34	8.39	Mean
Tongi Khal	Tongi	6.08	4.83	4.95	5.06	5.16	5.26	5.38	5.48	5.57	5.66	5.73	5.78	Upper Range
				4.95	5.06	5.15	5.22	5.29	5.35	5.40	5.45	5.49	5.53	Lower Range
				4.95	5.06	5.15	5.24	5.33	5.41	5.49	5.54	5.59	5.64	Mean
Turag	Mirpur	5.94	4.57	4.71	4.82	4.90	5.04	5.17	5.27	5.36	5.44	5.50	5.53	Upper Range
				4.71	4.81	4.87	4.95	5.00	5.06	5.10	5.14	5.18	5.22	Lower Range
				4.71	4.81	4.89	4.99	5.08	5.16	5.22	5.27	5.31	5.34	Mean
Buriganga	Dhaka	6.00	4.18	4.33	4.42	4.51	4.67	4.80	4.90	4.98	5.06	5.11	5.13	Upper Range
				4.33	4.41	4.47	4.55	4.60	4.65	4.68	4.72	4.77	4.81	Lower Range
				4.33	4.42	4.49	4.61	4.70	4.77	4.82	4.86	4.91	4.94	Mean
Balu	Demra	5.03	4.52	4.63	4.74	4.85	4.95	5.06	5.18	5.28	5.37	5.45	5.52	Upper Range
				4.63	4.74	4.84	4.93	5.01	5.09	5.16	5.22	5.28	5.33	Lower Range
				4.63	4.74	4.85	4.94	5.03	5.13	5.21	5.28	5.35	5.40	Mean

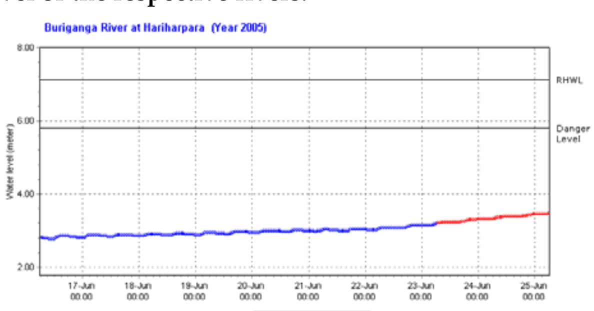
Output-4. A sample of Inundation map is based on the 48 hours forecasting.



Output-5. A sample of urban inundation map (for Dhaka city in this case) produced by FFWC and based on their flood forecasting data.



Output-6. A sample of a hydrograph that FFWC shares on the observed and predicted water level of the respective rivers.



3.2 Local level initiatives

A recent work by ADPC with CDMP (DMIN) has compiled and reported on various promising local level initiatives that emerged in the last decade or so in Bangladesh. The following table provides a list of such initiatives and a comparative overview of these initiatives.

Table 3-1. Various local level climatic hazard related EW initiatives developed in the country.

Initiative	Major Hazard focus	Dissemination mode-protocols	On parallel dissemination flow for EW
CPP initiative	Cyclone (also Tsunami recently)	VHF radio, CPP volunteers, collaboration with local setup	Emphasis on existing CPP-BDRC and collaboration with Govt. system
CFIS/CFAB project	Riverine flood	SMS and Fax; flag hoisting	Parallel dissemination flow recommended upto union system and flag operators
CEGIS-BDPC (LDRRF in Lalmonirhat) project	Multi-hazard (Flood, drought, Cold spell and erosion)	SMS and Fax; flag hoisting. 5-days lead-time is operational	Parallel dissemination flow recommended upto union system
BDPC and FFWC	Riverine flood	SMS and Fax; flag hoisting	Parallel dissemination flow recommended upto union system and flag operators
CNRS Flash Flood under LDRRF	Flash flood	1-2 and 3 day lead-time requirements shown. Talked about a need for a communication plan. Specific protocols are not specified.	FFWC/BWDB and IMD/Indian universities' collaboration suggested
ActionAid-BDPC project	Flood	SMS and Fax; flag hoisting	Parallel dissemination flow recommended upto change agents
BUET study under UNOPS and CDMP	Cyclone and Tsunami	WorldSpace Satellite system	Parallel dissemination flow recommended upto community and remote areas
CEGIS-BWDB/JMREMP initiative	Riverbank erosion	Fax, maps and flag hoisting in vulnerable areas	Parallel dissemination flow recommended upto union system

Source: Adapted from ADPC: July, 2009.

Among these promising hazard specific local level initiatives, four initiatives are discussed in detailed in following section. This would include:

- Initiative 1: Cyclone Preparedness Programme (CPP) initiative
- Initiative 2: BWDB's CFIS/CFAB initiative for riverine flood
- Initiative 3: Riverbank erosion prediction initiative of BWDB-JMREMP;
- Initiative 4. Drought assessment and planning using DRAS model; and
- Initiative 5. BMD's agro-meteorological forecast.

3.2.1 Initiative 1: Cyclone Preparedness Programme in the coastal zone of Bangladesh

The Cyclone Preparedness Programme (CPP) initiative is one of the leading efforts for cyclone early warning and management in the region. For generating EW, primarily, the programme receives a warning message first from BMD (Storm Warning Center) and then from DMB, DRR, MoFDM and other stakeholders by Fax. CPP disseminates the cyclone and storm related early warning to their thirty two well established CPP field offices and coordinates at the local level through a well-organized volunteer structure of CPP and BDRCS. The programme has been operating for more than thirty years and still remains as the major model of cyclone preparedness and EW dissemination in the coastal region of the country. The programme in coordination with BDRCS, DMB, DRR, local government and all levels of disaster management committees try to make preparations for evacuations in the coastal areas of the country. Shelter management, social work, first-aid service and coordination with the local government are also standard activities of the programme.

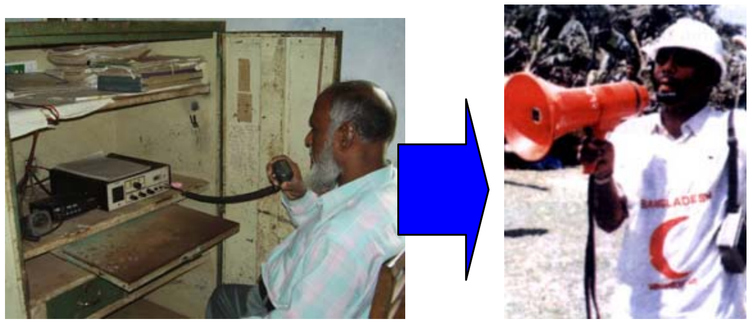


Figure 3-6. Local level dissemination system of the CPP.

The CPP has encouraged community based volunteerism and works through a voluntary mechanism at the community level where a big success has been observed in recent times in saving lives of the people in the community. The simple public dissemination system developed by the CPP and its institutional mechanism involving the local volunteers remained as the major success of the initiative. The hand mikes and megaphone type of public address systems have been a popularly used to reach out to the communities as a mode of local level dissemination.

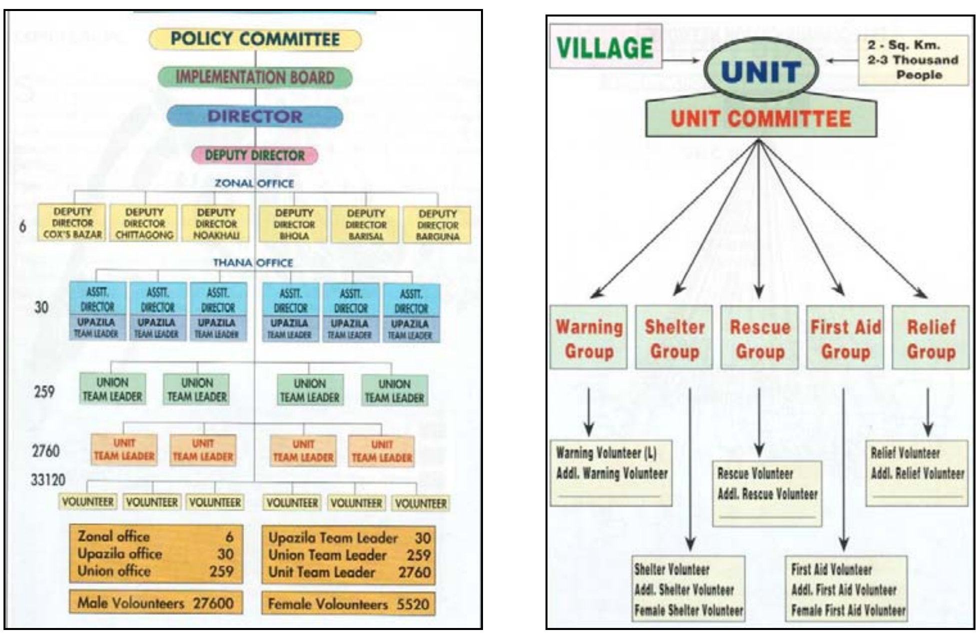


Figure 3-7. The institutional setup of CPP.

One of the challenges faced by the CPP program in recent time is its fullest coverage to safeguard people's livelihoods besides their life. In this respect, further additional development of this type of people centric community level early warning and to expand measures to protect people's livelihoods (e.g. saving standing crops, households assets) would be a major value added initiative.

3.2.2 Initiative 2: BWDB's CFIS-CFAB initiative for riverine flood

The Community Flood Information System (CFIS) has been experimented in recent time under various collaborative initiatives under by BWDB, WARPO, Riverside Technologies Inc., CEGIS, USAID, CARE, ADPC, BDPC and EMIN (from 2001 onward). The CFIS initiative aimed to disseminate information on the flood extent, duration and depth of water to the communities before a flood occurs. The system was based on a GIS-based flood forecasting information software called WATSURF, which uses a correlation model of a 248 square km study area. It is a simple gauge-to-gauge correlation-based tool that uses forecasted water levels from the FFWC as input. The calculated water levels are then used to generate flood water levels in the study area using GIS technology. The conceptual diagram of the CFIS is shown in Figure below.

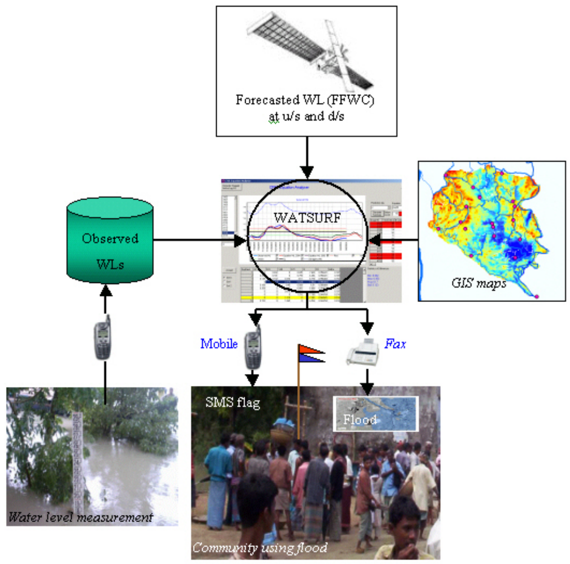


Figure 3-8. CFIS/CFAB information flow and dissemination process.

The CFIS system disseminates flood warnings to the pilot areas in a unique way. Selected individuals in the community serve as the operators to receive a daily text message with flood warnings and operate the flag system and bulletin board to inform the community of the flood warning. The message and symbols were designed with participation of the local people. The initiative has helped raise some level of awareness amongst local people about flood forecasts and warnings. Flood warnings are conveyed to local people by change agents and volunteers who explain the implications and interpretation of different types of warnings and help with flood preparedness. At the union level in the community UP members and chairman plays a central role in relaying the messages out to the local agents, volunteers, traditional leaders, teachers and a host of destination points. The warning messages then reach the farmers and community households using local modes of communications. At the village level, the flag system is also often used.

In recent times, the CFIS model has been taken even further through an active collaboration between ADPC, CARE, CEGIS, IWM, CFAN, G-Tech, USA, ADPC and FFWC and has been further piloted and specified with a relatively longer lead-time forecasting system. The CFAB has advanced the method to a greater number of areas as well as the extent of lead-time along with interpretation of the forecasts for the agriculture sector and safeguard of crops and other properties through involvement of the communities and local level institutions.

Figure 3-9. CFIS/CFAB information flow and dissemination process using flag hoisting.

This initiative has a good potential to be considered as a national system, particularly in the riverine systems. Gradual developments can be made on a basis and river specific zones for further refinement and increase of lead time. The dissemination system developed under this process also acknowledges the union systems (UP and associated Union DMC) as major stakeholders for community based early warning at the ground level.

One of the challenges this initiative has demonstrated is the flood information for the areas beyond or far from the riverine areas. The geographic locations that are inland from the riverine areas are yet to be covered/tested under this initiative. People often want to know more information on flooding beyond the river water level. Also, the initiative is based on a cellular communication for relaying the flood forecasting information to the community. This can be further simplified for a further widespread expansion using more community level modalities. Expansion of this type of initiatives in other river systems and in the tidal rivers in the coastal areas is a challenge for future.

3.2.3 Initiative 3: Riverbank erosion prediction initiative of BWDB-JMREMP

In the Jamuna and other river major systems BWDB with CEGIS has stated developing a local level erosion prediction method. At the local level, localized river erosion vulnerability maps were demonstrated in the union parishad, UNO offices and other public places. These products were found to be understood to a significant level by the local communities, particularly by the local government representatives. Furthermore, area wise demarcation of vulnerable zones was tried out using flags in the most vulnerable areas. The local government representatives along with the BWDB local officials were in charge of managing these flags and the dissemination of information among the local communities for preparedness and voluntary resettlements. However, there is much remaining before this pilot based erosion information can be taken to a greater scale. Some of the erosion vulnerable maps produced are shown in following figure.

For river bank erosion prediction, the BWDB with support from CEGIS developed a morphological and riverbank erosion prediction method based on satellite images. Since 2002, this kind of prediction has been generated through predicting morphological developments in the Jamuna River at the Pabna Irrigation and Rural Development Project (PIRDP), and FAP 21. From 2004 onwards, BWDB-CEGIS has been predicting the bank erosion along the Jamuna and Padma rivers yearly under the framework of the Jamuna-Meghna River Erosion Mitigation Project (JMREMP) and the Environmental Monitoring and Information Network for Water Resources Project (EMIN).

The system has exemplified the value of involving the local government (UP) and the UNO in the overall process of planning and regimentation for slow onset disaster preparations on the ground. This could be a good example for slow onset hazard planning and network development and can be linked up with upazila levels systems in the future.

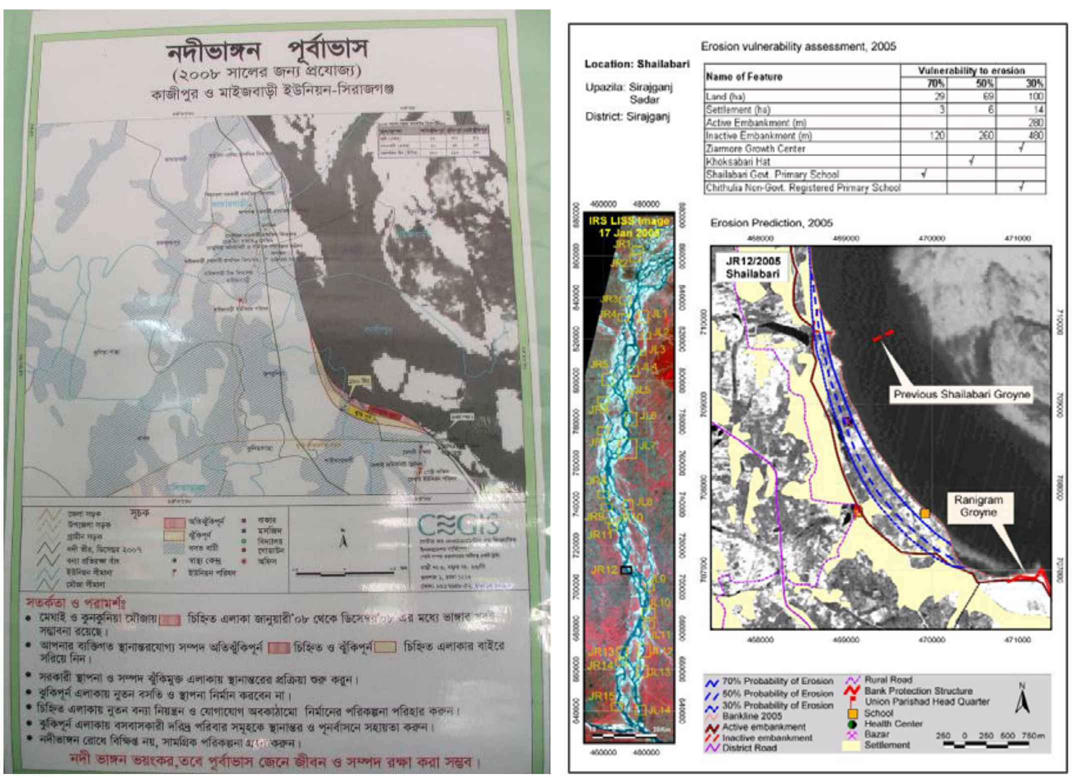


Figure 3-10. Erosion prediction and vulnerability assessment materials by BWDB.

3.2.4 Initiative 4: Drought assessment and planning using DRAS model

Bangladesh normally faces two types of drought i.e. transient and invisible. The drought has also three aspects i.e. hydrological, meteorological and agricultural. Drought as an agricultural phenomenon refers to conditions where plants are responsive to a certain level of moisture stress that affects both the vegetative growth and yield of crops. Drought and drought intensity are characterized primarily based on moisture retention capacity of the soil and infiltration.

Numerical prediction of drought is absent in Bangladesh. However, Bangladesh Meteorological Department (BMD) provide climatological and agro-meteorological forecast for 7-10 days, monthly and three monthly and disseminate to the Ministry of Agriculture, Department of Agricultural Extension (DAE) and Food and Agricultural Organization (FAO). It gives indication of rainfall predication and possibility of continued low/insignificant rainfall. It defines insignificant rainfall as 25 percent below normal rainfall during forecasted period. It is to be noted that Bangladesh Meteorological Department has initiated a project "Numerical Weather Prediction (NWP)" for numerical predication of weather which will able to provide better forecast in future which needs speedy internet connection, higher computer capability and skilled man-power.

Centre for Environment and Geographic Information Services (CEGIS) has also developed a drought assessment model called DRought ASsessment or DRAS in short with BARC. The DRAS model was piloted in various selected sites with BARC and DAE in various agro ecological zones. This model has a good potential to be mainstreamed in the national drought situation prediction system in future. A conceptual framework of the DRAS model is shown in the figure below.

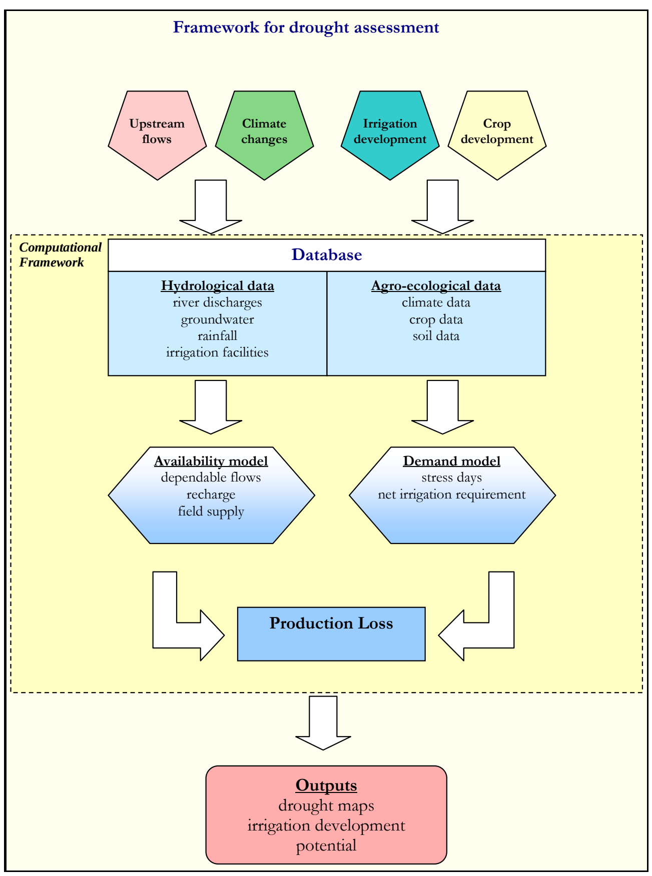


Figure 3-11. Conceptual framework of DRAS model.

3.2.5 Initiative 5. BMD's agro-meteorological forecasting

Bangladesh Meteorological Department's agro-meteorology department has started to provide a seven-day forecasting in recent years. The recent format provides rainfall forecast, mean surface temperature forecast, information on free water loss, sunshine hour with highlights, weather advisory and regular weather related information for the sever-day forecast period. The forecast is now also provided in a GIS layout with district administrative boundary on it. This initiative has been an encouraging initiative which is solely provided on the basis of the observed data and forecast outputs centrally from the country and then circulated to the various line agencies, ministries and non-government entities. The following figure shows such a latest agro-meteorological forecast bulletin for seven days time period.

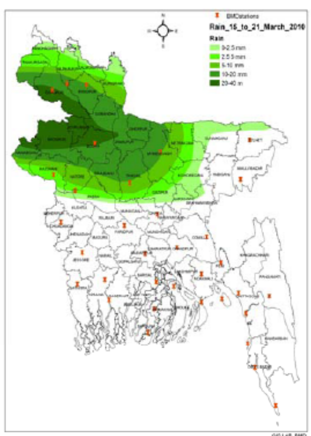
বাংলাদেশ আবহাওয়া অধিদপ্তর

Government of the Peoples' Republic of Bangladesh
Bangladesh Meteorological Department
(Meteorological Headquarter)
Meteorological Complex, Agargaon, Dhaka-1207.

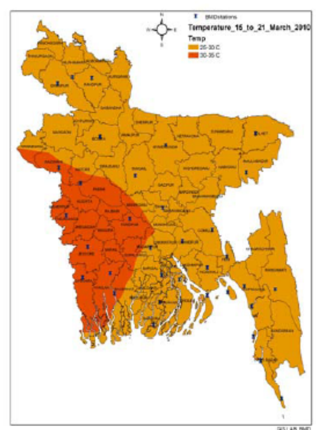
Agm-3 (2)/2010/ **11** **Issue date:** 15-03-2010

Forecast for the period: 15.03.2010 to 21.03.2010

Rainfall forecast
Period 1st half of this week



Mean Surface Temperature forecast
Period : This week



Highlights:

Free water loss during 08.03.2010 to 14-03.2010 was averaged 4.46 mm per day.
Sunshine hour during 08.03.2010 to 14-03.2010 was averaged to 8.7 hours per day.

Advisory for the period from 15-03-2010 to 21.03.2010.

Free water loss during the 1st week of March 2010 is expected to be between 4.25 to 4.75 mm per day.
Bright sunshine hour during the 1st week of March 2010 is expected to be between 7.0 to 8.0 hrs per day.

Weather:

- Light to moderate rain with thunder shower accompanied by temporary gusty or squally wind speed 60-80 km or more may occur at many places over Rangpur, Rajshahi, Dhaka and Sylhet divisions and one or two places else where over the country with a chance of hail at places during the the period .
- Slight fall in day temperature are expected over the country during the period.

(Md. Shameem Hassan Bhuiyan)
Meteorologist
For Director
Bangladesh Meteorological Department
Dhaka-1207.

Figure 3-12. BMD's agro- meteorological bulletin for 7-days time period.

A comparison of various hydro-metrological hazard early warning status was documented in a recent study by ADPC which is adopted below to provide a broad comparative picture of the status of the early warning and to inform where this is situated now.

Table 3-2. A comparative overview of the various hydro-metrological hazards EW in Bangladesh.

	EWS source agencies	EWS availability stage	Source to destination connectivity (in project areas)	Information content type transferred to local level	Community Dissemination mode	Information/material quality	Timing/ lead-time of the early warning
Riverine Flood	FFWC (BWDB)	Existing stage	Good	Bulletin, SMS, Fax, Call	Flag, agency instruction, local government notification, news media	Good	72 hours daily and 4-10 days with improved accuracy
Flash Flood	FFWC, IWM, ADPC	Developmental stage	Poor	Bulletin, SMS, Fax, Call	Flag, agency instruction, local government notification, news media	Medium (experimental)	24 hours (Experimental)
Cyclone	BMD, IMD, UK	Long standing, Redundant systems available	Very good	Bulletin, SMS, Fax, Call, Megaphone, Door to Door through volunteers	Flag, agency instruction, local government notification, news media	Very good	Very good. 72 hours
Drought	SRDI, SMRC, DAE, CEGIS (DRAS model)	Experimental stage	Poor	Agricultural departmental notification (DAE, Irrigation etc.)	Official notification	Poor	Not available
Riverbank erosion	BWDB-CEGIS,JMREMP	Developmental stage	Poor	Maps, Satellite imagery, BWDB notification	Land zoning and are planning	Good	Seasonal
Coastal erosion	BWDB-CEGIS, IWM, JMREMP	Experimental stage	Poor	Maps, Satellite imagery, BWDB notification	Land zoning and are planning	Good	Seasonal
Urban Fire	National Fire Brigade and Services	Non-scientific methods exist	Medium	Phone call, inter-personal communication	Fire brigade services, bells, community response	Simple	Not available

Climate change trend	UNFCCC C, SMRC, National research institutes (i.e. IWM, CEGIS)	GCM and RCM models existing and local downscalin g are underway	Poor	Policy formulation , NAPA, Adaptation project developme nt, mainstream ing exercise	Education and awareness raising	Complica ted	Modeling results are available

Source: ADPC (2008)

Chapter 4. Capacity Building Experiences: a growing need at all levels

In LACC-II process, Asian Disaster Preparedness Center (ADPC) and the LACC II Project Management Unit (PMU) have provided inputs to build capacity of the local level professionals on climate change and livelihoods based adaptations. ADPC has brought experiences from the region and engaged in these training and capacity building initiatives in a gradual manner.

First in April, 2008, ADPC has organized their full-scale "Regional Climate Risk Management Training" in Bangkok where multiple professionals from DAE and Ministry of Agriculture have participated and received training. Follow up to that, ADPC has organized and undertaken a series of local level training programs (four events in October, 2008) for Upazila Officials and Operational level officers on "Fundamentals of Climate Risk Management". This round of training was widely appreciated by the upazila level officials and block level operational officers in both drought prone and coastal areas.

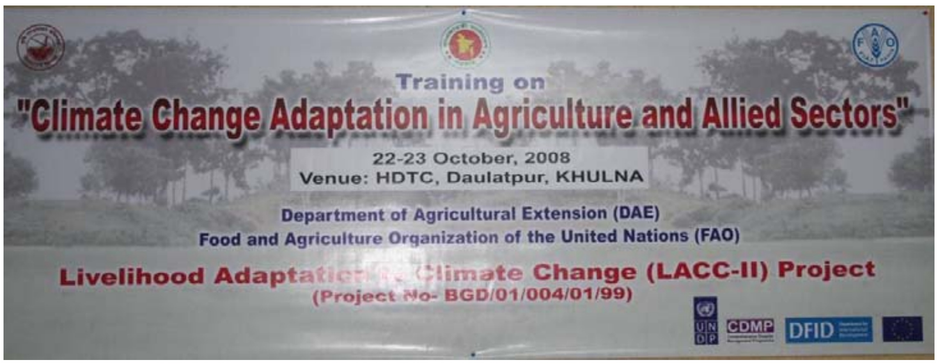
In a summarized manner, ADPC inputs remain both directly connected and in-directly facilitated in following training and capacity building activities under LACC-II project:

- Local level Climate Change and Adaptation Basic Training for Upazila level officials (Facilitated by ADPC resource team)
- Local level Climate Change and Adaptation Basic Training for Operation level officers (Facilitated by ADPC resource team)
- Technical Training on Sectoral Adaptation (ADPC assisted in devising the training and connected the resource person and PMU has carried out the events)
- National level Climate Change Forecast Applications Training and Learning (Facilitated by ADPC resource team).

4.1 Local level trainings on climate change and adaptation

The "Local Level Climate Change and Livelihoods Adaptation Training" round was organized to train sub-district (upazila) and block level operational professionals from the six different districts of the project pilot area. In this round the training events were an integral part of the overall capacity of the DAE and other agency professionals in building skills in climate change and adaptive capacity building for operations at local level.

The major objective of the training program was to increase adaptive capacity of the local level (upazila and block/implementation level) and other operational professionals in a systematic way. Through this training the local level officials and operational professionals were given orientation on the major issues and themes of climate change, adaptation and its linkages with overall risk management through systematic adaptation process.



The trainees were exposed to the Climate change fundamentals, its relationship with overall disaster management, climate forecast applications and the various ways, means and options of agricultural climate change in a practical ways. The livelihoods adaptation measures from local perspective as well as from scientific perspectives were elaborated for their internal understanding and capacity building.

4.1.1 Schedule of training events

The training program was carried out in two rounds: Pabna round and Khulna round. Considering the two different regions of the project: drought prone northwestern area and in southern coastal area this arrangement was made. The Participants were invited from all project pilot areas and were divided in four "one-day" training programs as per the structure adopted for participation. The training dates and locations are mentioned in the table below.

Table 4-1. Local level training schedule for four events.

Region	Date	Location	Training audiences
Drought prone pilot upazilas of northern districts	October 19, 2008	Pabna	**Training 1:** Upazila level officials from the drought prone pilot upazilas
	October 20, 2008	Pabna	**Training 2:** Project implementation level operational officers from the drought prone pilot upazilas
Coastal pilot areas of southern districts	October 22, 2008	Khulna	**Training 3:** Upazila level officials from the coastal pilot upazilas
	October 23, 2008	Khulna	**Training 4:** Project implementation level operational officers from the coastal pilot upazilas

4.1.2 Training delivery modality and participants

The delivered training sessions were largely based on the information exchange and capacity building in a shared mode. A total of over hundred professionals were training in the four trainings in two rounds. Training programs were "one-day" events and divided into multiple modules. Training programs were carried out separately in two different days. On the first day, the "upazila level official"(e.g. Upazila Agriculture officer, Upazila fisheries officer, PIO and equivalent level of professionals etc.) were trained. Discussion based approaches were carried out in this day along with PowerPoint presentations. In the day-two, the training program was carried out for the "Operational level officers" (e.g. SAAOs, Project officers and so forth). In this training session more workshop oriented and more easy access materials were shared and a "hands-on approach" was adopted for the participants.

In both type of sessions the experiences of the trainees were explored from the empirical situation and tried to share during the training discussions. Lectures were delivered in a way that each group can "internalize" the new issues of climate change in a practical manner and be able to generate a dialogue on the issue reflecting their own context and situation. In this respect, the examples of the drought prone areas for the northern two trainings in Pubna round were shared while the coastal vulnerabilities, coastal adaptations and other issues of coastal climate change issues were shared in the final two trainings in the Khulna round training.

The delivery language was primarily "Bangla". For those presentations and materials which remained in English were delivered through simultaneous translation through the pool of resource trainers and necessary interpretation were made available to the participants. The ADPC team took actions to maintain the quality of the training sessions. ADPC professionals shared the overall outline of the training and had briefed both the training team and the trainers at the beginning of the session.

4.1.3 Resource persons

The training program at local level were developed with active contribution of the resource persons from various areas of climate change, agricultural adaptation and disaster management related professionals. Trainers come from multi-disciplinary background and with a wide range of experience of working in the livelihoods based adaptation in agriculture sector as well as disaster and climate change programs. The training team comprises of both international and national professionals. Some of the key resource professionals and trainers for this local level capacity building exercise were: Atiq Kainan Ahmed, Livelihoods Vulnerability and Climate Change Adaptation Expert (Lead Trainer), Dr. Jayaraman Potty (Climatologist, Early Warning Team, ADPC, Dr. Abu Wali Raghib Hassan (from DAE), Dr. Satendra Singh (from PMU), and Sanjib Saha (from PMU). In addition to the above trainers, expert guidance for were received from Dr. Stephan Baas, Lead Technical Officer from FAO headquarters and from AR Subbiah, Director, Climate Risk Management Department of ADPC for developing the training materials in a sequential manner.

4.1.4 Training delivery experiences

The course was designed in three technical modules and with an additional formal opening session for effective administration of the training sessions. The ADPC trainers with active support from the PMU have taken initiatives to accommodate any necessary adjustments deemed necessary on the spot of after training and maintained the quality check for each training materials and sessions rigorously. After each day of training, the training resource team has sat together for necessary modifications and adjustments for the subsequent sessions. The two rounds of "back to back" trainings has been found useful for the participants as they could share their immediate experiences with each other after during and after the sessions in their own field of work. The sessions under three technical modules and opening session as progressed are outlined in the following table and in discussed below.

Table 4-2. Session details of the local level training by ADPC.

Module	Session
Opening Session	• Opening Remarks: PMU,CDMP, ADPC, National/local host • **Presentation:** LACC-II Project overview • Overview of CDMP (only in Khulna round) • Structure and outline of training • Orientation of the participants and briefing on logistics
Module One: Climate Science and Fundamentals	• **Ice breaker Exercise:** Observation on CC and its impact on agriculture (in card) • **Lecture:** Climate Change Fundamentals • **Lecture:** Climate Forecast Applications • **Exercise and discussion:** Climate Forecast Applications at local level
Module: Two: Climate change Impacts and Adaptation	• **Lecture:** Climate Change Impacts and Adaptation in Agriculture Sector • **Group exercise and discussion:** Identification of sectoral impacts of climate change
Module: Three: Climate change Adaptation and Evaluations	• **Guided adaptation evaluation:** Participant's evaluation of LACC-II Adaptation measures • **Mini talk(s) on CCA/participants presentation:** Innovative Agriculture Risk Management Approaches (e.g. IPM/Integrated Fisheries/Extension as adaptation) • **Group discussion and plenary**
	Concluding remarks

A typical training program day started in each morning around 8:30 with a formal opening session. In the brief formal opening session each day, opening remark from PMU, CDMP (in Khulna round), ADPC, and national experts assessed the need for training and capacity building of professionals on emerging issue of climate change and climate change adaptation. From the PMU an overview of the LACC project was given to situate the project activities and the training. At each day, the structure of the training was also explained upfront so that the participants understood the process and mode of the training. This was useful in making a routine track of the day's activities and adjustment of the session timings during the course of the day. In the opening session a self-orientation of the participants and resources persons were carried out to let everyone introduce with others. Usually the logistics brief would end the formal opening session and situate a farm background for rest of the day's activities.

4.1.5 Module 1: Ice-breaker exercise on Climate change

Before the first technical module (Module 1: Climate Science and Fundamentals), a unique session was designed and carried out for participants ice breaking. As the participants came from various areas and the issues is relatively new, the ice breaker exercise was found very useful to start the module activities. There are three ice breaker questions were given to the participants one after another and asked the participants to write their answers in a card (distributed separately earlier). Each of the cards were collected up on completion and then participants one by one shared their existing thoughts and answers on those questions.

The three ice-breaker questions are as follows:

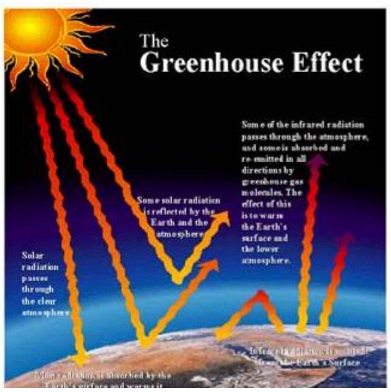
1. Define "climate change" in your own terms? *(Jolobayu poriborton bolte apni ki bojhen?)*
2. Please identify some elements of climate change *(Jolobayu poriborton er koyekti niyamok chinhito korun)*
3. Please indicate some impacts of climate change *(Jolobayu poribortoner koyekti probhab chinhito korun)*

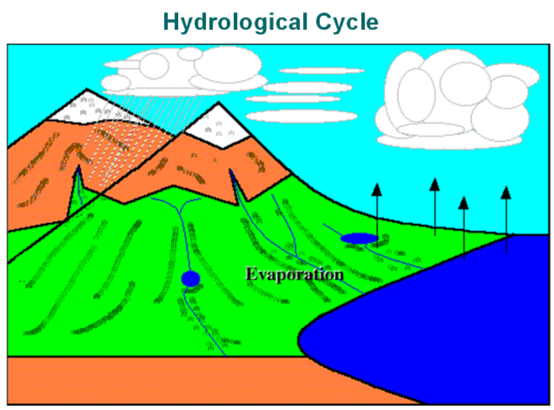
Some of the definitions of the participants on climate change are as follows:

- Climate change is an issue of long term trend
- Climate change is a change of temperature
- Climate change is a factor of erratic change in natural phenomena
- Climate change means a change in temperature and rainfall
- Many others articulated in the training by the participants.

4.1.6 Module 1: Lecture on Fundamentals of Climate Change

In the first module of the training it was thought that the participants should have a clear idea about the scientific reasoning of climate change. Keeping this in mind, a lecture on fundamentals of climate change was designed. In this lecture, the concept of climate change, the differences between the weather and climate change, issues and reasons of green house effect, hydrological cycle process and other features are discussed in an easy format. Special attention was given to make the scientific issues present in a very simple manner to the participants so that they can understand easily the whole gamut of climate change science part relatively easily but can discuss effectively afterwards as well.





In the discussions the definitional issues were discussed taking time and making necessary references to the scientific literature existing from standard sources such as IPCC Fourth Assessment Report and so forth. Some of the definitions are as follows:

Defining two mutually different terms "Weather" and "Climate",

- **The Weather**: the state of the atmosphere (Earth) at a given time. (hours -days)
- **Climate**: the average atmospheric conditions over longer periods of time (say 30 years).

Defining the term "Climate Change",

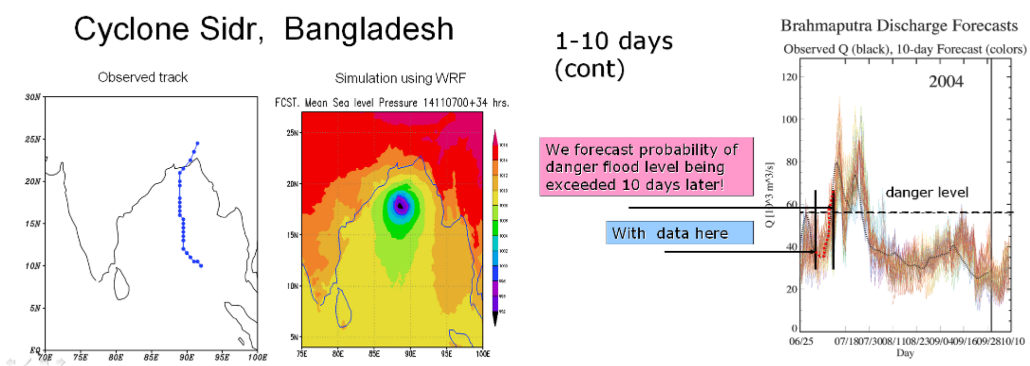
"… any change in climate over time, whether due to natural variability or as a result of human activity" (IPCC: 2007)

"… a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods" (UNFCC)

4.1.7 Module 1: Lecture on climate forecast applications and an exercise

After delivering on the fundamentals of climate change it was clearly understood (also articulated) by the participants that the climate change will increase both the frequency and intensity of various types of hazards in future and these hazards will make more disasters to the agriculture and allied sectors in coming days.

With this background it was emphasized that climate forecast applications can help people to prepare for future such risks and develop their adaptive capacity in this line. In the second lecture on climate forecast applications examples are given of various forecast applications such as CFAB project for flood preparedness and mathematical weather forecasting examples of tracking cyclone and so forth.



From the first two lectures the participants understood that although the climate change is quite apparent scientifically, this can be both mitigated further as well as the adaptation is possible to these future climatic risks.

This module ended with a facilitated exercise on hand on forecasting using past representative rainfall and temperature data over districts in Bangladesh. A data table was given for the period 1990 to 2005. From the data participants were asked to generate: a) normal rainfall for the period; b) draw the normal rainfall line in a chart (give to then in a sheet), c) mark the rainfall and temperature each year in the chart, and d) find out the drought and flood years during those period from the graph. The whole exercise was facilitated by the resource trainers and the participants appreciated this kind of hands on exercise very much.

4.1.8 Module 2: Lecture on Climate Change Impacts and Adaptation

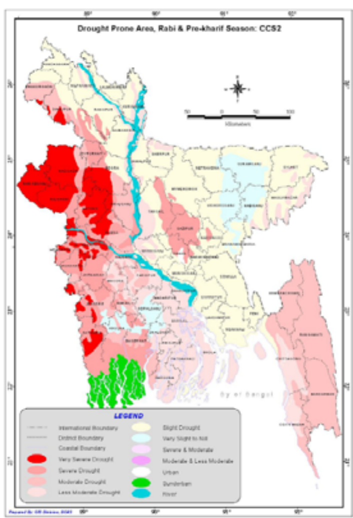
From the first module which was more on science and its applications, the second module was solely more on climate change adaptation and its societal applications for increasing adaptive capacity at local and sectoral levels. In the second module, issues of climate change relating to Bangladesh were given priority and the need for climate change adaptation was made clear to the participants. The lecture started with situating the climate change context of the country and parameters of anticipated changes are likely for 2030, 2050 and 2100 in Bangladesh. The potential level of mean temperature, precipitation and Sea Level Rise were discussed following the national and international standards.

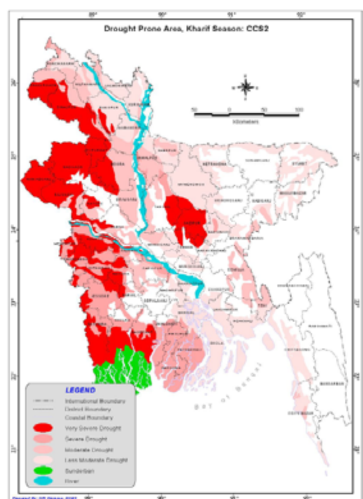
Year	Mean Temperature Change (°C)			Mean Precipitation Change (%)			Sea Level Rise		
	Annual	DJF	JJA	Annual	DJF	JJA	IPCC (Upper range)	SMRC	NAPA
2030	1.0	1.1	0.8	5	-2	6	14	18	14
2050	1.4	1.6	1.1	6	-5	8	32	30	32
2100	2.4	2.7	1.9	10	-10	12	88	60	88

Note: DJF= December-January-February; JJA= June-July-August, SMRC= SAARC Meteorological Research Center *(Source: Adopted from IPCC 2001, OECD Report 2003)*

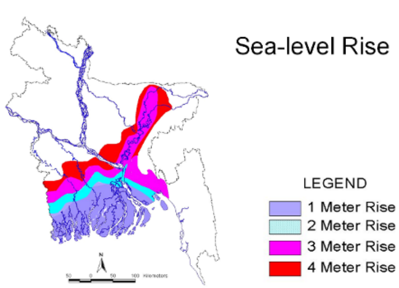
To contextualize the drought situation, both the existing and the anticipated changes, various issues were discussed and references were shard with the participants. Some of the likely impacts were discussed with the participants and discussions carried out within the lecture on such issues. This session was a lecture and discussion driven session and the participants could actively participate in the discussion for necessary clarification and new understanding. Some of the following maps are also shared with the participants to show the potential impact of drought, water, soils, SLR etc. Necessary updated reference materials were shared with the participants. For the coastal zone relevant parameters were shared as well.

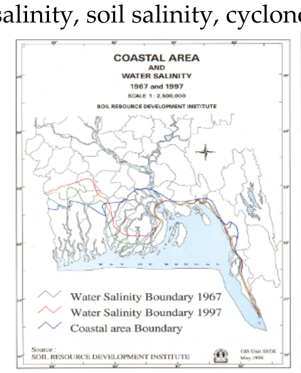
Drought maps:

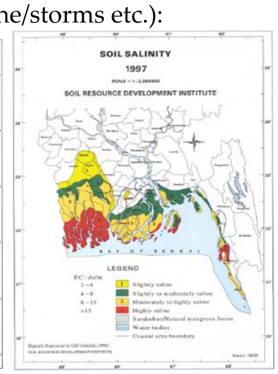




Likely coastal impacts (SLR, water salinity, soil salinity, cyclone/storms etc.):







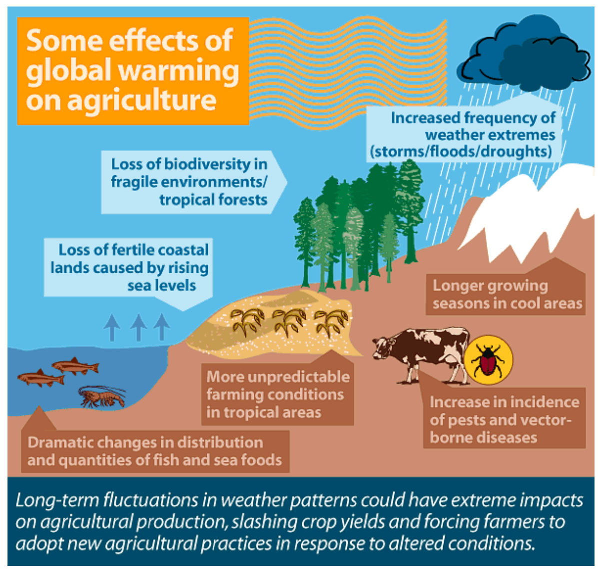
Primary Physical Effects / Agents of Change		Salt-water Intrusion	Drainage Congestion	Coastal Morphology	Cyclone and Storm Surges
Climate change (temperature, precipitation, evapo-transpiration)		+	+	-	+++
Changes of upstream river discharge	Peak	-	++	+++	-
	Low	+++	-	-	-
Sea level rise		+++	+++	++	++
Subsidence		++	++	++	++

Source: Rahman, A., and Alam, M., 2004

This lecture has covered the climate change impacts on agriculture and allied sectors and shared the issues of likely impacts on the agriculture and allied sectors.

Some of the likely impacts anticipated by scientists are as follows:

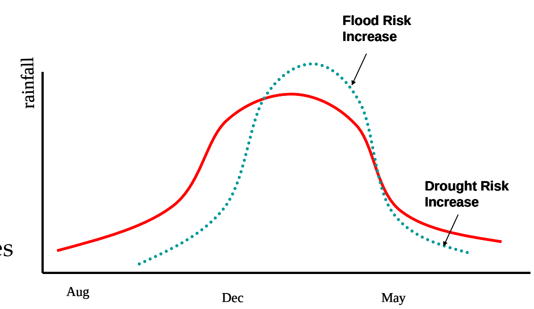
- Changes in water resources demand and availability. Precipitation, evaporation, transpiration, etc., can all change. Flood control, drainage, and irrigation infrastructure will have to evolve with the changes.
- Greater risks for monoculture.
- Changes in disease and pest ranges and severity. Changes in temperature, hydrologic regime, frost dates, etc., will affect disease and pest prevalence, and host susceptibility.
- Coastal inundation, saline groundwater intrusion, drainage congestion. As sea level rises, low-lying countries will be affected.



In this module, a major issue of delivery was to discuss and clarify the term of "adaptation" and share why adaptation is needed and how a systematic livelihoods based adaptation can uplift the adaptive capacity of the people and local level institutions in a gradual manner.
Some of the issues discussed as below:

Why wee need adaptation?

- Climate change impacts become apparent
- Failing to reduce greenhouse gas emissions
- Responding to a changing climate requires adjustments and changes
- Sustainable development linkage



What is "Adaptation"?

"Adaptation is the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (IPCC:2007)

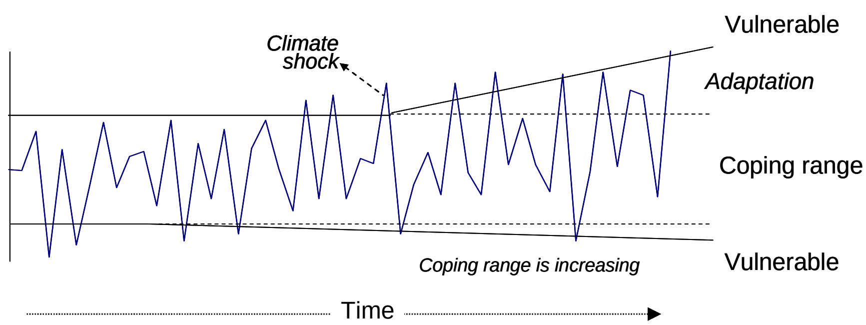
Other definitions:

> "Adaptation" is possible adjustments (spontaneous or planned) of people, plants or ecosystems to climate change to reduce adverse impacts, to take advantage of opportunities or to cope with the consequences of climate change".

Various types of practiced types of adaptation (WRI: 2007):

- Serendipitous/unanticipated adaptation
- Climate-Proofing of Development Efforts
- Discrete Adaptation

During the discussion in this module it was discussed that adaptation is actually a process of adjusting to changes in variables that influence (e.g. human wellbeing and survival, ecosystems) and it can take place at different levels, with different actors, different levels of consciousness, purpose and timing. It was also discussed that "livelihoods based adaptation" is a people centric solution based on both local-knowledge with the scientific facilitation. It is dual-way process and builds on the adaptive capacity through a systematic process.



It was shown to the participants that for this gradual adaptation in a "systematic ways" a processual approach is needed and he LACC project with DAE is taking that unique approach to build capacity at local and institutional levels.

4.1.9 Module 3: Exercise on the evaluation of adaptation measures

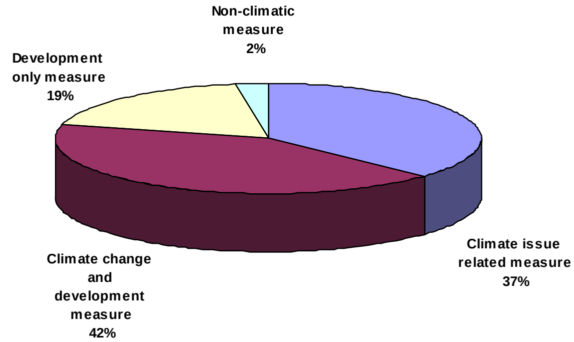
In the final module a very useful round of group work on climate change adaptation evaluation was developed. On the basis of the acquired knowledge of the participants from the previous two modules, participants were asked to evaluate the adaptation measures (that are collected earlier under the LACC-I and LACC-II project) using a "Criteria for evaluation". In this exercise of evaluating the adaptation measures following four criteria were used. Participants were given all the lists of the adaptation measures in four groups (usually by sectors such as agriculture, fisheries, forestry and livestock) and requested to classify each of these measures under any of the four criteria. Four criteria are:

- Climate issues related measure
- Climate change and Development measure
- Development only measure
- Non-climatic measure

This exercise made the participants understand the differences of the "adaptation specific measures" from the "regular development measures" which are not always associated to the climate change adaptation immediate or long term options. Participants found this exercise useful for generating discussions with their own rationales but with increased knowledge this time with the knowledge of knowing which is a adaptation measures and which is not.

4.1.10 Outputs of the adaptation option evaluation results

The evaluation exercise was carried out in 11 (eleven) groups from the four trainings (both for the senior and junior officers rounds) and the results shown below is an outputs and analysis of the major trends from these 11 sets of results.



The results indicate that (shown in the pie diagram on the right) the participants perceive that most of the adaptation options identified in the project are either directly related on the climate issues (37%) or of dual nature of climate change and development (42%). It indicates that almost 80% of the adaptation measures are in some way contributes towards the climate change adaptation for the livelihoods. A very small number (2%) of the measures are identified as these do not have any relationships with climate change at all. A proportion of 19% measures from the list are also identified as are often solely contribute towards the regular development work of the departments and agencies.

A more detailed account (from the dominant perceptions) are shown in the table below for each of the adaptation options as identified by the participants in their 11 group exercise results.

Table 4-3. Adaptation measures as classified by the participants from their evaluations.

SL	Adaptation Options	Climate issue related measure	Climate change and development measure	Development only measure	Non-climatic measure	Remarks
1	Seedbed method for T. Aman rice	■				
2	Depth of transplanting for T. Aman		■			
3	Weed control-reduce water seepage	■		■	■	Mixed responses
4	Manual closing of soil cracks Farmers		■			
5	Strengthening field bunds (Ail lifting)		■			
6	Impact of water saturated soil condition on rice cultivation		■			
7	Raise seedbed in the high land and prepare floating seedbed		■			
8	Zero tillage potato and maize cultivation		■			
9	Cultivation of local and HYV T. Aman rice to assess the comparative advantages of the varieties in the recurrent drought and saline condition	■				
10	Cultivation of saline tolerant local and HYV Boro rice to assess the comparative advantages of the varieties in the recurrent saline problems in the coastal area	■				
11	Re-excavation of traditional ponds	■	■			Dual response
12	Re-excavation of khari canals (north-west)		■			
13	Excavation of canals		■			
14	Water Control Structures	■				
15	Excavation of mini-ponds	■	■			
16	Re-excavation of traditional canal and preserving fresh/sweet water in the canal by erecting mud bund/wall for subsequent irrigation		■			
17	Canal re-excavation for supplementary Irrigation (south-		■			

SL	Adaptation Options	Climate issue related measure	Climate change and developm ent measure	Developm ent only measure	Non-climatic measure	Remarks
	west)					
18	Facilitate drainage by re-excavating the traditional canals					
19	Supplemental Irrigation					
20	Installation of shallow and Deep Tube Wells					
21	System of Rice Intensification					
22	Direct sown rice (drum seeder)					Dual response
23	Drought resistant rice varieties					
24	Green Manure - T.Aman system					
25	T. Aus - Chini atap system					
26	T. aman - Mustard/linseed system					
27	T. aman - Chickpea					
28	T. aman - Mung bean					
29	Relay cropping of T. Aman with grass pea and mustard					
30	Cultivation of pulse, oil, spices crops					
31	Famine reserve crops					
32	Jujube cultivation					Dual response
33	Homestead vegetable gardening					
34	Mulberry intercropping in rice					Dual response
35	Fodder cultivation					
36	Fish cultivation in mini ponds					
37	Cottage industries					
38	Manufacturing industries					
39	Mini Nursery					
40	Mixed Fruit Garden					
41	Cultivation of Pigeon Pea (Arahar) in the Fallow Land					
42	Boat garden					
43	Indigenous fish culture in pond such as Koi, shing, Rui, Katla etc					
44	Pata (Compartmentalization by bamboo mat in stagnant water) fish cultivation					
45	Prawn (golda) culture in low land/ T. Aman rice field					
46	Small pond Fish breeding practices					Mixed responses
47	Cultivate saline tolerant fish					
48	Protecting fish by putting-up fench/net around the pond					
49	Vegetable cultivation at the boundary of shrimp/prawn field (gher)					Dual response
50	Snail Cultivation in water lodged area					
51	Goat rearing					
52	Duck rearing					
53	Drought resistant poultry (Cok) rearing					
54	Cultivation of water lily in the water logged area					Dual response
55	Flower cultivation					
56	Mango cultivation					
57	*Maize cultivation					Mixed responses
58	*Papaya Cultivation					
59	Community based biogas and tree planting					
60	Improved stove					Dual response
61	Seed storage for higher viability					
62	Farm Yard Manure					
63	Compost preparation					Dual

SL	Adaptation Options	Climate issue related measure	Climate change and development measure	Development only measure	Non-climatic measure	Remarks
						response
64	Cultivation of green manuring crops					
65	Timber and fruit tree plantation in the roadside and in the homestead					
66	Establishment of embankment to restrict saline water intrusion from the sea					
67	Establishment/maintenance of embankment and sluice gate for saving crops from high tide and flood					
68	Social mobilization for the Management of embankment and sluice gates through the water user groups in one union as pilot basis for growing rice and other crops as suitable to the area					

4.1.11 "Mini talk" on innovative CCA

Besides the technical lectures, group-work and discussions several new issues have also emerged and was accommodated for sharing in the form of "Mini Talk" during the training. Some of the unique innovative measures emerged in these sessions (specific to the context) as follows:

- Integrated Pest Management (IPM)
- Fisheries adaptation,
- Hydroponics (*bayra*) in Salinity/SLR areas
- Extension experiences of DAE as adaptation
- Cyclone/storm surge specific adaptation measures
- Farmer's climate field school
- Traditional adaptive measures
- And some others.

4.1.12 Learning outcomes

The learning outcome of this local level training program remained as below. Participants gained:

- exposure to fundamentals of climate change and science relevant for agriculture and allied sector in Bangladesh;
- understanding of the applicable knowledge in climate change impacts on agriculture and allied sectors;
- understanding of the climate change adaptation process (options, measures, scientific adaptation, spontaneous adaptation, adaptive capacity etc.) and various types of livelihoods based adaptation options and their evaluation process in agriculture and allied sectors;
- introductory knowledge and understanding of the various available Climate Forecast Application Systems. Increased understanding of the available sources of forecasting, prediction and early warning systems related to Flood, Drought, Cyclone and so forth; and
- access to an "active learning environment" for discussing climate change and climate change adaptation related discussions at local level.

4.2 National level training and learning on Climate Forecast Applications

Besides the local level training programs, ADPC has also carried out a training and learning event on "Climate Forecast Applications for Agriculture and allied sectors" on 15 October, 2009 which as hosted at the AIS Conference Room, DAE, Khamarbari, Dhaka. The overall objectives of the national level training program was to share and learn various issues of Climate Change related issues relating to adaptation approaches and Climate Forecast Applications (CFA) that would help better manage of the climatic risks in agriculture and allied sectors in Bangladesh. From the sharing and learning of the event participants are expected to be able to get further ideas on how climate change forecast can be applied in various settings and local conditions in an applied manner.

The Director General of DAE has participated in the inauguration session as a Chief Guest and opened the event for the participants. He has given a thoughtful welcome address and given various examples in the recent time where the need for climate forecast applications vis-à-vis early warning was expressed highly. He has also pointed out that agriculture sector development is a major policy thrust for the current government and DAE would like to build their operational capacity to adapt with the ongoing climatic changes and variability in all the ecological zones of the country. In this regard, he has thanked FAO, LACC project and ADPC for bringing along a timely training and capacity building program on CFA. In the end of this session, the training team has given a briefing on training objectives, elaborated the upcoming sessions and laid out the overall agenda of the day.

Figure 4-1. DG DAE is addressing the participants during the ADPC and LACC-II project facilitated "Climate Forecast Application training and learning event in Dhaka on 15 October, 2009.

The specific objectives of this national level training program were to:

- capacitate the participants to understand and gain applicable knowledge on the available model results of the anticipated climate change related risks and impacts from an over-view of the existing model results available from regional, national and sub-national level;
- share updates on various available Climate Forecast Application Systems with increased details of sources and process of forecasting, prediction and early warning systems related to Flood, Drought, Cyclone and so forth.
- create greater understanding of the various "forecast products" available (also coming up) that would be relevant for agriculture and allied sectors in Bangladesh;

- facilitate an institutional and adaptive learning process that could be useful for future use of existing forecast products, have a regular interaction with the information source providers (e.g. BMD) and the practitioners (DAE officers and project) and researchers;
- provide participants systematic understanding of the climate change adaptation (options, measures, scientific adaptation, spontaneous adaptation, adaptive capacity etc.) and various types of livelihoods based adaptation options that could be developed using available CFA related products; and
- Facilitate an "active learning environment" for discussing climate change and climate forecast applications and adaptive learning at national to local level in future.

4.2.1 Target participants

Approximately a cross section of 40 professionals have participated (excluding the trainers) in this training and learning event. The training and learning event is targeted primarily for the following participants:

- LACC-II project NTIWG members;
- DAE's Disaster Risk Management and Climate Change Core Group members;
- LACC-II project field officers (FOs); and
- Others who showed interest from DAE and remained actively involved in related activities.

4.2.2 Trainers and resource persons

The training and learning event was developed with active contribution of the institutional resource persons who are involved in various types existing climate forecast applications in the country. In this respect, resources persons were invited from Bangladesh Water Development Board's Flood Forecasting and Warning Center (FFWC) who are involved with hydrological risks such as floods in the country. Resource person was also invited from the Bangladesh Meteorological Department (BMD) particularly having specialization in agro-meteorological hazards and forecast systems. Experienced resource trainers were also drawn from the national agricultural research institutions such as BRRI and BARI to provide more updates on recent developments and get into discussions with forecasters and users. ADPC provided the overall facilitation of the training and learning process and active learning. ADPC trainer presented various facts, figures and climate change model result output (based on various existing sources) and facilitated the overall learning process in the event.

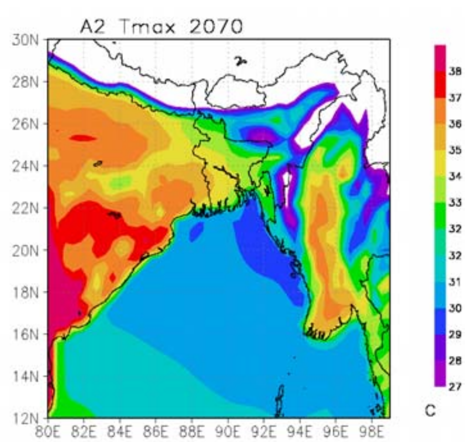
The training team comprises of multi-disciplinary and multi-agency professionals. Some of the key resource professionals and trainers for this local level capacity building exercise are as follows:

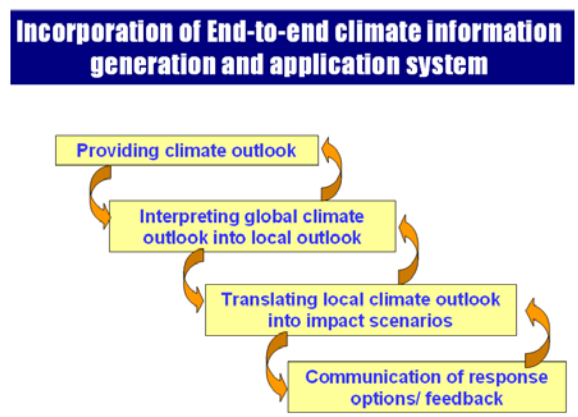
- Dr. Shameem Hassan Bhuiyan, BMD
- Mr. Mr Abul Bashar, FFWC/BWDB
- Mr. Atiq K. Ahmed, ADPC (Lead Facilitator)
- Dr. Jiban K. Biswas, BRRI
- Dr. Akkas Ali, BARI
- Dr. Abu Wali Raghib Hassan, DAE
- Mr. Sanjib Saha, LACC-II, PMU, FAO; and
- Mr. Abul Hossain, DAE.

4.2.3 Technical Session-I: Early warning and Probabilistic Forecast Systems

The major technical aspect of the training program was structured in two different rounds. In the first round, three technical presentations were delivered from ADPC, BMD and FFWC. In the first presentation of this round Mr Atiq K. Ahmed from ADPC has provided an elaborated presentation on the Climate Change and Anticipated Risks to Bangladesh and particularly in the project pilot areas. The presentation has touched the gradual downscaling of climate change model results from various initiatives such as IPCC AR4, PRECIS model run results for various parts of Bangladesh, anticipated climatic risks to the coastal zone of Bangladesh and so forth. He has discussed how these risks are increasingly putting the agriculture and allied sectors in higher risks in coming years. The presentation pointed out that these increasing patterns of climatic risks on the agriculture and allied sector are creating a larger need to enhance capacity to predict those for local level. In this respect, incorporation of “end-to-end” climate information generation and application system is crucial and climate forecast applications based agricultural risk management strategies should be adopted.

It was pointed out that the overall capacity of the institutions and professionals should be further enhanced for a) analyzing climate outlooks, b) interpreting global climate outlook into local outlooks, c) translating local climate outlook into impact scenarios, d) communication development for response options/ feedback; and e) improving planning and adaptation strategies for local level preparations in a dynamic way.



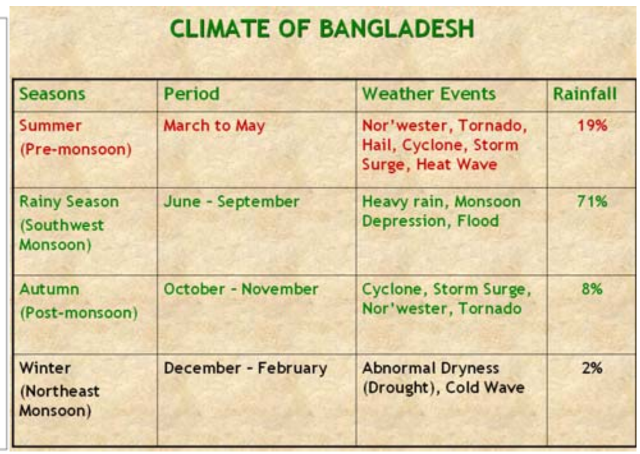


He has also put emphasized on the initiating a CFA process and gradually build an enabling environment where professionals and farmer groups can have a better understanding of the available climate forecast information systems of the source agencies such as BMD, FFWC and others and build an operational relationship with these agencies for developing a process of CFA for agriculture and allied sectors.

Follow up to this presentation, Dr Shameem Hassan from Agro-meteorology division of BMD has given a comprehensive presentation on the Early Warning and Probabilistic Forecast in Meteorological Systems in Bangladesh. He has talked about seasonal climatic patterns of Bangladesh and its various impacts of the agriculture systems, various means adopted by BMD to monitor agro-meteorological information, various agro-meteorological forecast products developed by BMD which can facilitate CFA process and DAE and other relevant issues. He has informed that BMD produces following “Agromet Bulletin” from the observed Agromet and Meteorological data in every 7th day which contains the following information:

- 7 day actual rainfall in mm
- 7 days normal rainfall in mm

- Departure (in %) of actual rainfall with normal
- No. of Rainy days
- Maximum temperature and normal Maximum temperature
- Minimum temperature and normal Minimum temperature
- Average evaporation and Evapotranspiration
- Average sunshine hours
- Weather Forecast for next 7 days
- Advisories for the farmers

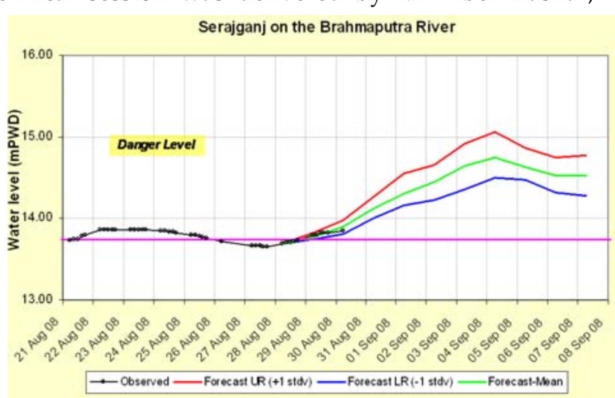


CLIMATE OF BANGLADESH

Seasons	Period	Weather Events	Rainfall
Summer (Pre-monsoon)	March to May	Nor'wester, Tornado, Hail, Cyclone, Storm Surge, Heat Wave	19%
Rainy Season (Southwest Monsoon)	June - September	Heavy rain, Monsoon Depression, Flood	71%
Autumn (Post-monsoon)	October - November	Cyclone, Storm Surge, Nor'wester, Tornado	8%
Winter (Northeast Monsoon)	December - February	Abnormal Dryness (Drought), Cold Wave	2%

He has expressed a more collaborative arrangement for CFA with DAE local offices and BMD stations which might also very useful for producing more useful and downscaled information. He has pointed out that in future with increased capacity the NTWIG members and DAE core unit can play a core role in developing such initiative with BMD agromet division.

The last presentation of this round of technical session was delivered by Mr Abul Bashar, FFWC/BWDB and he has elaborated on the hydrological observations and flood forecasting system in Bangladesh. He has also discussed on the various potential use flood forecast products developed by the FFWC which could be useful for agriculture risk management and planning in an elaborated way. He has talked about the FFWC activities, forecast products and how these can be accessed and used. He has elaborated to the participants how these flood forecast products can be interpreted for understanding the local situations.



A follow up discussion on summary of the learning was undertaken briefly on these three presentations in the end of this round of technical session.

4.2.4 Technical Session-II: CFA, Adaptive Practices & Decision Making

Follow up to the technical session-1 on the early warning and probabilistic forecast systems in the first half of the day, a participatory round exercise was carried out to have an elaborated understanding of the applications of climate information, adaptive practices and decision making issues. The overall objectives of this participatory round was to bring the operational professional and DAE officials close to the climate information source providers such as BMD and FFWC representatives and bring along the agricultural research organization professional to elaborate on some of the possible adaptive practices that can be adopted to deal with the climatic changes/variability in future.

During this session, Dr Jiban K Biswas from Bangladesh Rice Research Institute (BRRI) and Dr Akkas Ali from Bangladesh Agricultural Research Institute (BARI) have shared some latest research outputs which could be helpful for future adaptation of crops in drought and coastal regions in the country. Dr Jiban K Biswas from BRRI has elaborated on the environmental and climatic risks growing both in the saline prone areas as well as in the drought prone areas of the LACC-II pilot upazilas. He has suggested that BRRI dhan-27, 40, 41, 47, BR-11, 23 are among the suitable rice varieties for saline area.

Cover crop like sweet potato, sweet gourd etc. are also suitable for saline prone areas. Other crops such as watermelon, *batishak*, radish and radish etc. can also be suitable in these given areas. He has suggested that salinity management through fertilizer management is also crucial and further research is needed on deep water rice for coastal region as well. The BARI representative Dr Akkas has shared their experiences of developing the homestead vegetation model for saline areas in Khulna. They have recommended nine production units for homestead model.

Event Agenda

9:00am Registration

Inauguration and Opening Session

9:30am	Welcome Address from LACC-II project-PMU, DAE (by Dr Abu Wali Raghib Hassan) Welcome Address from ADPC (by Atiq K. Ahmed, ADPC, Thailand) Speech of Chief Guest by Director, Director General, DAE Briefing on Training Objectives and Session Overview
10:15am	Presentation: Training activities under the LACC-II Project: An Overview (By Dr Abu Wali Raghib Hassan)

Tea Break

Technical Sessions Round I. Early warning and Probabilistic Forecast Systems in Bangladesh

10:45am	Presentation: Climate Change and Anticipated Risks: Overview of Global, National to Local Challenges for Climate Risk Management for Agriculture and Allied Sectors (By Atiq K. Ahmed, ADPC)
11:30am	Presentation: Early Warning and Probabilistic Forecast in "Meteorological Systems" (by Dr Shameem Hassan, BMD)
12:15am	Presentation: Early warning and Probabilistic forecast in "Hydrological Systems" (by Mr Abul Bashar, FFWC/BWDB)
1:00pm	Discussions and Learning (Facilitated by Mr Atiq K. Ahmed, ADPC)

Lunch Break and Prayer

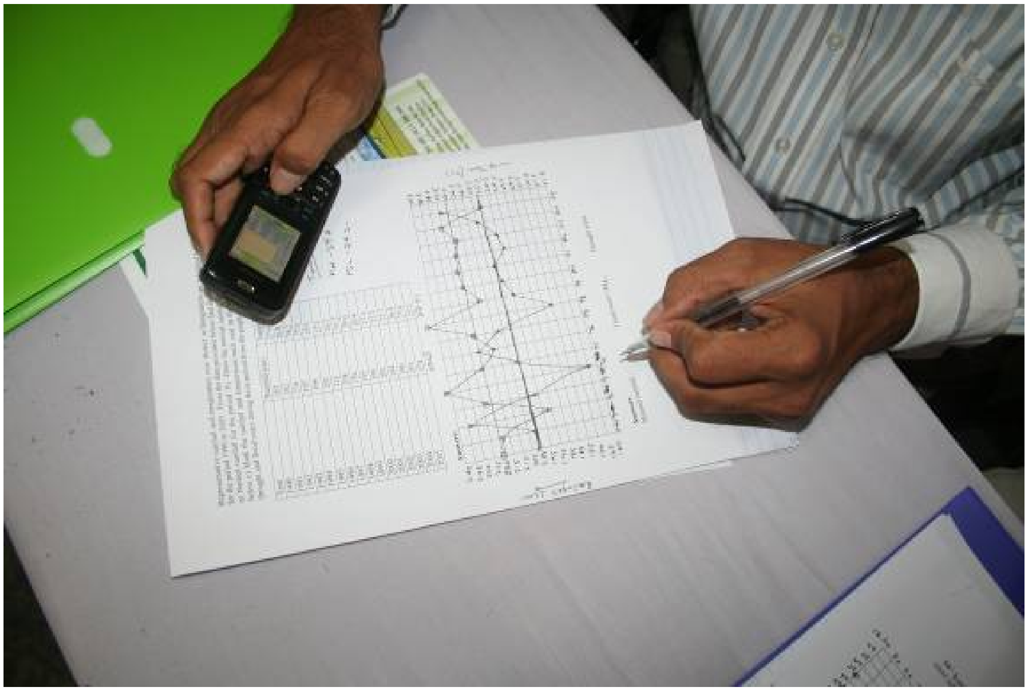
Technical Sessions Round II. Climate Forecast Applications, Adaptive Practices and Decision Making

3:00pm	"Work-group" and plenary: Integration of Climate Forecast Information into Agricultural decision making and planning (Facilitated by Atiq K. Ahmed, ADPC and Sanjib K. Saha, PMU, FAO)
4:00pm	Two resource presentations and shared learning on: Adaptive Measures for Crops in Drought and Coastal Regions: Current Practices and Future Potential (by Dr Jiban K Biswas, BRRI and Dr Akkas Ali BARI)
5:00pm	Open discussions and experience sharing

Summary and Wrap Up by ADPC and PMU.

Closing remarks and vote of thanks by Director, FSW, DAE.

Chapter 5. Reflections and recommendations



5.1 Recommendations from local level trainings

From the experiences of administering of the local level training on climate change following recommendations emerged:

- It was emerged from the overall local level interaction that ***there has been a great demand for further training on climate change and adaptation issues in future***. More trainings on wider issues of adaptation and more frequent trainings are also asked for.

- It was pointed out in several occasions that "one-day" trainings on climate change issues are useful but a longer term program of a ***"week-long training"*** would be very useful for the participants to get more hands on training and application of trainings in future. In this respect, a week long training or even two-week long training would give them more opportunities to design effective projects/initiatives for adaptation which they can follow up within their departments and sectors respectively after the training.

- It was emerged from the discussion that if a ***"Guidebook on Community Level Climate Change Adaptation"*** is developed in future then it could be very useful for them. A guidebook in Bangla with these types of issues of climate change and adaptation of science and society is recommended.

- From the experiences of the local level training on climate change and adaptation a training manual can be further developed and the existing resource book (FAO Case Study 9) can be ***further updated incorporating the coastal contexts*** into the guidebook or preparing a separate resource book altogether for coastal areas. This is quite important as the situation and the context of the Bangladesh coastal zone is quite different from the northern drought prone areas.

- For developing further widespread understanding of local level stakeholders some ***information and education related materials*** (i.e. paper based – billboards, posters, leaflets and audio-visual such as video/film etc.) relating to climate change and climate change adaptation can be developed and shared with the local level units/stakeholders.

- It is recommended that to share the training experiences of local level capacity building can be shared with the national level officials in Dhaka. A half-day ***central level sharing meeting*** can be organized in future. The meeting can be organized at DAE headquarters and central level DAE officials, NTWG members and other relevant national level stakeholders can be invited for this sharing meeting.

5.2 Recommendations from the NTWIG level training event

A host of issues and recommendations emerged from the national level/NTWIG training on climate forecast applications. Participants actively recommended following issues and shared experience driven lessons.

- **District level expansion of Technical working groups:** It was suggested that on top of the existing institutional arrangements of NTIWG and UTIWG there is a need for strengthening institutional capacity at district level which is needed for aligning the climate change issues with the district plans and implementations.

- **Climate Information product development:** It was pointed out during the discussion that in collaboration with BMD and DAE custom based climate information products needs to be developed particularly for the Sea Level Rise-salinity prone coastal areas and in the drought prone areas.

- **Extend long-lead on agro-meteorological forecasts:** It was pointed out that for agro-meteorological forecasts the present available time is not very suitable for agricultural preparedness. In this respect, extension of long-lead time of agro-meteorological forecasts are asked for and requested from the BMD agro-meteorology department.

- **Expansion of flood forecast for coastal areas:** The available forecast information products provided for flood from the FFWC needs to include the coastal areas and rivers as well.

- **Adjustment of cropping pattern and planting time of crops:** Participant discussed that CFA should be mainstreamed in the practices of farmers and block level practitioners. The crop management plans and timing could be adjusted using the forecast information if these are made available in time with adequate geographical extent.

- **Regular involvement of agricultural research outputs:** Agricultural research institutions can be further involved with the extension services from the beginning of any research activities so that farmers and block level SAAOs can also be engaged from the beginning of any research activity.

- **CFA related further training and awareness:** Further awareness can capacity building program for CFA needs to be undertaken and should be adopted in future projects initiatives both within DAE, Ministry of Agriculture as well as in collaboration with the other departments and ministries.

Annexes

Annex 1. Reflections of participation in the four trainings at local level

Participants of "Pabna-round" training

Participants of "Khulna-round" training

Various other images of group-work and presentations


Climate Change – major reason
Already EVIDENT


IMPACTS OF CLIMATE CHANGE IN AGRICULTURE


পরিবেশ বান্ধব কৃষির জন্য
আইপিএম

Annex 2. Reflections of participation and learning in National (i.e NTWIG) level.







Annex 3. Some relevant reference materials

Books and reports

Baas, S and Selvaraju, R (2007). Climate variability and change: Adaptation to drought in Bangladesh: A resource book and training guide
http://www.fao.org/nr/clim/abst/clim_070901_en.htm

ADPC (2005). Training modules for climate & flood forecast applications in agriculture. ADPC-FAO.
http://www.fao.org/sd/dim_pe4/pe4_060201_en.htm

FAO (2006). Livelihood Adaptation to Climate Variability and Change in Drought-Prone Bangladesh. FAO.
http://www.fao.org/sd/dim_pe4/pe4_061103_en.htm

Ahmed, AK and Chowdhury IA (2006). Study on livelihood systems assessment, vulnerable groups profiling and livelihood adaptation to climate hazard and long-term climate change in drought-prone areas of Northwestern Bangladesh. FAO.
http://www.fao.org/sd/dim_pe4/pe4_060701_en.htm

CEGIS (2005). Strengthening disaster risk management in the agricultural sector in Bangladesh. FAO.
http://www.fao.org/sd/dim_pe4/pe4_051201_en.htm

Relevant Websites:

FAO and Climate Change website
http://www.fao.org/climatechange/home/en/

FAO and Emergencies
http://www.fao.org/emergencies/current-focus/climate-change-adaptation/en/

FAO "Climpag" website
http://www.fao.org/nr/climpag/

Flood Forecasting and Warning Centre (FFWC), Bangladesh
http://www.ffwc.gov.bd/

Climate Forecast Applications Bangladesh (CFAB)
http://cfab.eas.gatech.edu/shortterm/home.html

Bangladesh Metrological Department
http://www.bdonline.com/bmd/

Barind Multipurpose Development Authority
http://www.bmda.gov.bd/

Ministry of Agriculture, Bangladesh website
http://www.moa.gov.bd/

Relevant reports that discuss future climate risks (also bibliography for the Chapter 2):

IDS, 2007. Detailed Research Report. The ORCHID: Piloting Climate Risk Screening in DFID Bangladesh. April 2007.

DEFRA, 2007. Investigating the Impact of Relative Sea-Level Rise on Coastal Communities and their Livelihoods in Bangladesh. The UK Department for Environment Food and Rural Affairs. June 2007.

BUET, 2008. Preparation of Look-up Table and generation of PRECIS scenarios for Bangladesh. Bangladesh University of Engineering and Technology (BUET). November, 2008.

Annex 4 : List of participants in four local level training sessions

List of participants of two rounds of training for Junior Officers in Pabna and Khulna.

SL #	Name of participant	Name of Department / Organization	Tel./Cell No.	Zone	Date
1	Md. Azizul Islam	DAE, Bagatipara	1712441478	North	20 Oct., 2008
2	Md. A.Razzak	DAE, Bagatipara	01734-007681	North	21 Oct., 2008
3	Komol Kanti Kundu	DAE, Bagatipara	01717-331360	North	22 Oct., 2008
4	Md. Abdul Kuddus	DAE, Bagatipara	01718-878798	North	23 Oct., 2008
5	Md. Ashogor Ali	DAE, Lalpur	01715-715274	North	24 Oct., 2008
6	Md. Abdus Sattar	DAE, Lalpur, Natore	01718-28260	North	25 Oct., 2008
7	Md. Abu Ayube Ansari	DAE, Lalpur,Natore	01198-129334	North	26 Oct., 2008
8	Md. Monirul Islam	DAE, Sapahar	01916-557781	North	27 Oct., 2008
9	Shree Denesh Chondro Sarkar	DAE, Sapahar	01718-824622	North	28 Oct., 2008
10	Md. Ataur Rahman	DAE, Sapahar	01717-051566	North	29 Oct., 2008
11	Md. Abdul Mannan	Forester, Sapahar	01912- 935590	North	30 Oct., 2008
12	Md. Mainul Haque	DAE, Gomostopur	01712-392645	North	31 Oct., 2008
13	Md. Robiul Islam	DAE, Gomostopur	01718-878688	North	32 Oct., 2008
14	Md. Ibrahim Kholil	DAE, Gomostopur	01722-803550	North	33 Oct., 2008
15	Md. Humayun Kobir	DAE, Nachole	01712-986911	North	34 Oct., 2008
16	Md. Abul Hossain	DAE, Porsha	01719-613574	North	35 Oct., 2008
17	Md. Towhidul Islam	DAE,Porsha	01714-864841	North	36 Oct., 2008
18	Biddut K. Paul	FO(M),Bagatipara	01712-696152	North	37 Oct., 2008
19	Arif Jahangir	FO(M), Porsha,FAO	01713-247371	North	38 Oct., 2008
20	Elias Habib	FOM, Gomostapur	01711-333792	North	39 Oct., 2008
21	Md. Asadul Haque	FOM, Lalpur	01711-789380	North	40 Oct., 2008
22	Shah Md. Ashaduddowla	FOM, FAO, Nachole	01716-118116	North	41 Oct., 2008
23	Prodip Kumar Roy	FOM,FAO, Sapahar	01712-170591	North	42 Oct., 2008
24	Md. Aminul Islam	DAE, Nachole	01714-764522	North	43 Oct., 2008
25	Md. Golam Morttuza	DAE, Nachole	01715-271425	North	44 Oct., 2008
26	Md. Ganiul Islam	DAE, Porsha	01718-701281	North	45 Oct., 2008
27	Md. Shoriful Islam	Forest Dep., Nachole	01716-155797	North	46 Oct., 2008
28	Md. Mahfuz Ashraf	FAO - LACC-II	1731242416	South	23 Oct., 2008
29	Md. Rafiqul Islam	FAO - LACC-II	1733019012	South	24 Oct., 2008
30	Dwipendra Chandra Sarkar	FAO - LACC-II	1730194621	South	25 Oct., 2008
31	Md. Mizanur Rahman	FAO - LACC-II	01721-936448	South	26 Oct., 2008
32	Zillur Rahman	DAE, Terokhada	1914987252	South	27 Oct., 2008
33	S.M. …………	DAE, Terokhada	1914667545	South	28 Oct., 2008
34	Sachindra Nath Das	DAE, Bhandaria	1716301916	South	29 Oct., 2008
35	Chitta Ranjan Gain	DAE, Bhandaria	1718043633	South	30 Oct., 2008
36	Md. Ala Uddin SK	DAE, Dacope	01717-614771	South	31 Oct., 2008

SL #	Name of participant	Name of Department / Organization	Tel./Cell No.	Zone	Date
37	Das Bibhuti Ranjan	DAE,Dacope	01718-607117	South	32 Oct., 2008
38	Md. Kamal Hossain	DAE, Bhandaria	01736-200510	South	33 Oct., 2008
39	Md. Sultan Mahmud	DAE, Bhandaria	01714-801173	South	34 Oct., 2008
40	Md. Siddiqur Rahman	DAE.Nazirpur	01716-615235	South	35 Oct., 2008
41	Dhirendra Nath Sikder	DAE, Nazirpur	01715-350008	South	36 Oct., 2008
42	Nitish Chandra Bala	DAE, Nazirpur	01725-461126	South	37 Oct., 2008
43	Md. Habibur Rahman	DAE,Bhandaria	1724433663	South	38 Oct., 2008
44	Nirmal Krishna Biswas	DAE,Nazirpur	1710810317	South	39 Oct., 2008
45	Md. Babul Akter	DAE, Nazirpur	1912453719	South	40 Oct., 2008
46	SM. Ashrafuzzam	DAE,Terokhada	01710-120284	South	41 Oct., 2008
47	Md. Ekramul Haque	DAE, Tereokhada	01717-469932	South	42 Oct., 2008
48	Md. Younus Ali	DAE, Terokhada	1911803537	South	43 Oct., 2008
49	Bijan Kumar Roy	DAE,Dacope	01918-222709	South	44 Oct., 2008
50	Nikhil Chandra Biswas	DAE,Dacope	1715855975	South	45 Oct., 2008
51	Sadananda Mondal	DAE,Dacope	01915-018445	South	46 Oct., 2008

List of participants of two rounds of training for Senior Officers on 19th October 2008 in Pabna (Venue: HDTC, Tebunia Pabna)

S.L	Name & Designation of Participant	Name of Department / Organization	Tel./Cell No.
1.	Md. Abul Kalam Azad UAO	DAE, Nachole, Chapai nababganj	01716126185
2.	Md, Ohiduzzawali	DAE,Gomostapur	01711-378050
3.	Md.Sana Ullah Meah	D.D.A.E. Pabna	01732-062876
4.	Dr. Biplob Kumar Dey	V.S,Livestock Office,Nachole	01712537127
5.	Dr. Md. Abul Hossain	ULO.	01711789872
6.	Md. Abul Hashim SAE	Panasi,BADC,Bagatipara	01720-466616
7.	Md. Nowsher Ali. SAE	B.ADC. Panasi, Lalpur	01916-406376
8.	Md. Niaz Muddin	U.L.O. Lalpur	01712277902
9.	Md. Mahbubur Rahman	UFO, Gomastapur	01711784840
10.	Md. Alamgir Kabir	UFO, Porsha, Naogaon	01711-930972
11.	S. M. Azharul Islam, UFO	DOF, Sapahar	01716-937692
12.	Dr. Md. Salim Uddin ULO	U.L. Officer Sapahar, Naogaon	01718-290095
13.	Pratul Chandra Sarker	Uao, Parsha,Naogaon	01714941444
14.	A.B.M. Mostafizur Rahman	UAO,(DAE), Sapahar	01712987962
15.	Md. Mobosher Hossain	AFO-Lalpur Natore	01712-439184
16.	K.M. Abdul Halim	UFO, Bagatipara, Natore	01716-729576
17.	Subrata Kr, Sarker UAO	DAE, Bagati , Natore	01715-844689
18.	Md. Ehsanul Haque	DAE-Lalpur Natore	01715176139

List of participants of two rounds of training for Senior Officers on 22nd October 2008 in Khulna (Venue: HDTC, Khulna)

S.L	Name & Designation of participant	Name of Department / Organization	Tel./ Cell No.
1.	Kazi Anisuzzaman UAO	DAE	01711397721
2.	Gour Kanti Singha UAO	DAE, Terokhada	01715-094094
3.	Md. Habibulla, Forester	Upazilla, Forster Dacope	01716-681088
4.	Kazi Anisuzzaman UAO,	DAE, Dacope Khulna	01711397721
5.	Dr. Ataur Rahman Chowdhury	ULO Dacope	01818-372989
6.	Md. Saiful Islam, Forester	Dept. of Forest, Bhandaria	01722-278777
7.	Md. Khayrul Islam, FG	FD , Nazirpur	01719-975299
8.	Sanjida Haque E.O	Fisheries, Dacope	01919-858984
9.	Md. Zillur Rahman	UFO, Bhandaria	01720-201447
10.	G.M Salim	UFO, Nazirpur	01712-699215
11.	Md. Abu Sayed	SUFO,Terokhada	01712-661616
12.	Dr. Shishir Kumar Biswas	DLS, Terokhada	01712-156234
13.	Swapan Kumar Mandal	UAO,Bhandaria	01716-421838
14.	Ashit Kumar Saha	UAO,Nazirpur	01712-257061
15.	Dr. Dinesh Chandra Mazumder	ULO,Bhandaria	01718-148425
16.	F.M. Mostafa		01912-475622
17.	S. M Ferdous	Metro. Agri.. Officer DAE	01711-184475
18.	Md. Golam Hossain	DDAE, Khulna	811486/041
19.	Md. Obaidur Rahman	Forester,Terokhada	01712-923376
20.	Md. Mizanur Rahman	FO9M, FAO	01721-936448
21.	Md. Jafor		01912-447551