

Research article

CLIMATE CHANGE DYNAMICS IN WATERSHED MANAGEMENT: AN APPRAISAL OF NATIONAL WATER MANAGEMENT PLAN (NWMP) PROGRAM OF BANGLADESH

Syed Abu Shoib^{1*}, Saiful Alam², Nahid Sultana³, M Aminul Haque², M Ali Hossain⁴

ABSTRACT

This paper identifies the process of generating and implementing plans, programs and project to maintain and enhance watershed functions considering the impact of climate change. As Bangladesh is one of the most vulnerable countries to climate change in the world, its water sector is under real threat. Most important factors that will change due to climate change in Bangladesh are: i) Heavier rainfall in monsoon season ii) Lower rainfall in winter season iii) Temperature rise iv) Melting of glaciers v) Sea level rise. vi) Increased Cyclone frequency. The National Water Management Plan (NWMP) has 8 clusters and 84 programs. The impact of Climate change on NWMP will be different for different programs. Some Programs have higher impact, some have medium and some have lower impact. The cluster main river has greater impact of climate change. The sea level rise and melting of Himalayan ice due to climate change will increase salinity intrusion, erosion and sedimentation process. Construction of Ganges Barrage, Brahmaputra Barrage and Meghna Barrage if designed

¹ Senior Lecturer, Department of Environmental Science, Independent University, Bangladesh. Bashundhara, Baridhara, Dhaka-1229
shoibmila@yahoo.com , Shoibmila@iub.edu.bd

² Principal Scientific Officer, Water Resources Planning Organization, Ministry of Water Resources, Banani, Dhaka, psowr@warpo.gov.bd, maminul_05@yahoo.com

³ Researcher, Institute of Environmental Studies, University of New South Wales, Sydney, Australia,
n.sultana@unsw.edu.au

*Corresponding Author

⁴ Professor and Head, Department of Environmental Science, Independent University, Bangladesh. Bashundhara, Baridhara, Dhaka-1229
mahossain@iub.edu.bd

considering the expected changes due to climate change will increase fresh water flow in dry season. The program like the water supply and distribution systems, sanitation and sewerage system under the cluster Towns and Rural areas and cluster major cities will have impact due to sea level rise, heavy rainfall and temperature rise due to climate change. The temperature rise will change the demand of water in different hydrological areas which will change the water supply and distribution systems. The height of the polder in coastal region and flood protection embankment require further consideration according to sea level rise. The increase of cyclone intensity, temperature, sea level due to climate change will have greater impact on the cluster Disaster Management. The increase of temperature scarcity of rainfall due to climate change will have negative impact on the cluster Environment and Aquatic Resources. The river pollution, biodiversity of the Haor basin and flood plain, salinity in the Sundarban will highly impacted by the climate change. The cluster institutional Development has no direct impact of climate change but the programs under this cluster require some changes and addition. The institutions that deal with water sector project require capacity building with respect to climate change issue. Modern tools, techniques and knowledge related to climate change are essential for better future planning. The programs under cluster Enabling Environment require to include some new legislations, rules and regulations which will help to minimize the negative impact of climate change on other programs. **Copyright © AJEPR, all rights reserved.**

Key Words: Watershed, Climate, plans, Development, Programs

1. Introduction

1.1. Watershed Management

Watershed management begins with understanding the basic concepts of watershed functions and values and learning how to protect or maintain a desired condition of that water resource. Each watershed is unique and includes particular elements that require individual attention, whether it is agriculture, industry, mining or feedlots, all must be managed in some way to protect the water and the land within the watershed. The main purpose of watershed management is to protect, maintain, and restore water resources in our watersheds. In order to do this, we must use proper planning and management of water resources and their uses; reduce the impacts of nonpoint sources of pollution on water resources; regulate activities for soil conservation and waterway and wetlands protection; form partnerships and build local capacity to restore and protect water resources. And, the most important part is educating citizens about watersheds and watershed management. Watershed management is the judicious management of three basic resources of soil, water and vegetation, on watershed basis, for achieving particular objective for the well being of the people. It includes treatment of land most suitable biological as well as engineering measures. The process includes: Production of food, fodder, fuel. Pollution control, Over exploitation of resources should be minimized, Water storage, flood control, checking, sedimentation, Wild life preservation, Erosion control and prevention of soil, degradation and conservation of soil and water, Employment generation through industrial development, dairy fishery production, Recharging of ground water to provide regular water supply for consumption and industry as well as irrigation, Recreational facility. In this paper a review of National Water Management Plan Programme (NWMP) of Bangladesh will be discussed considering the climate change impact. Figure 1 shows the qualitative path of the review.

1.2 National Water Management Plan(NWMP)

Resource ownership, allocation and rights determine how society decides to prioritize the use of water and its distribution according to broad objectives and goals. NWMPo confirms the state as the owner of all water resources. It also sets the priority of water use between sectors, and whilst reserving the right of Government to allocate environment. It should be specified in relative detail over the medium term, and in outline terms over the longer term. Where there are major unknowns and/or risks, these should be described together with

measures for resolving such uncertainties over specified time periods. The National Water Policy describes the NWMP as a plan that addresses “the overall resource management issues in each region and the whole of Bangladesh, and providing directions for the short, intermediate, and long runs. The plan is now executed by different agencies as determined by the Government from time to time. The NWMP and all other related plans are prepared in comprehensive and integrated manner, with regard for the interests of all water-related sectors. The planning methodology ensured co-operation across sectors and people's participation in the process (NWMP,2004). The NWMP thus addressed the whole water sector in a manner that fosters co-operation, and provide details of how, when and by whom the directives of the NWPo are to be implemented. The NWMP is a management plan. It’s a part of a wider framework by which the sector is to be managed. This framework also includes: Government policy, Laws, regulations and rules, Standards, guidelines and procedures, The National Water Resources Database and other GoB databases, a management information system, a monitoring and evaluation system. The Executive Committee of the National Water Resources Council (ECNWRC) is the top brass to resolve any interagency conflict in this regard.

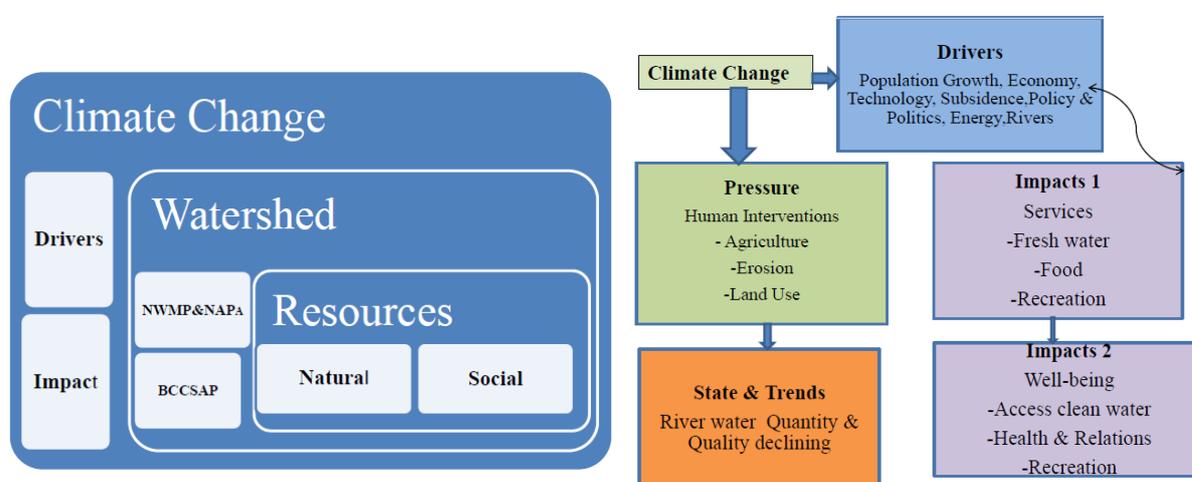


Figure 1: Climate Change Impact flow in Watershed

1.3 Climate change at global scale

The Intergovernmental Panel on Climate Change (IPCC) predicts that global temperature will rise between 1.8 °C and 4.0 °C by the last decade of the 21st century. As a consequence, the following changes are expected:

- Frequency of extreme hydrological events will increase
- Intensity of extreme hydrological events will increase
- Occurrence of erratic and unusual behavior of weather will be frequent
- Sea Level will rise; to what level is being debated
- Hot and humid conditions will increase the incidence of water borne and vector borne diseases like malaria, dengue fever and diarrhoeal diseases

The accelerating changes in our global climate will undoubtedly cause major changes in the patterns of water cycle. The magnitude and frequency of extreme hydrological events including precipitation, floods, cyclones, storm surges, and droughts and these phenomena would increase and adversely affect the water sector in the country. Changes in the hydrological cycle are directly linked with the occurrences of hydro-meteorological disasters and as a consequence these disasters are looming in a more intense and frequent pattern. Regional level climate change forecast with more reliability is still a gap; several institutions are working to meet the gap. In the mean time the strategy is to take up adaptation activities that will have ‘no regret’ as we have more detail data and information about impending changes.

2. Climate Changes for Bangladesh

Based on the scanty data analysis of the recent past data the following changes has been predicted for Bangladesh that indicates where future emphasis is required in the water resources management:

- Excessive rainfall at present, untimely and irregular distribution;
- Increase in tidal bore, no of cyclonic events, variation in tidal flow in the coastal regions;
- Increase infrequency of flash flood;
- Increase in surface temperature (ground and sea);
- Increase in droughts and dry spells, storms and hailstorms
- Intensity of mist fog increased in the winter.
- Monsoon rainfall has shifted;
- Severity of cold and its duration is decreasing

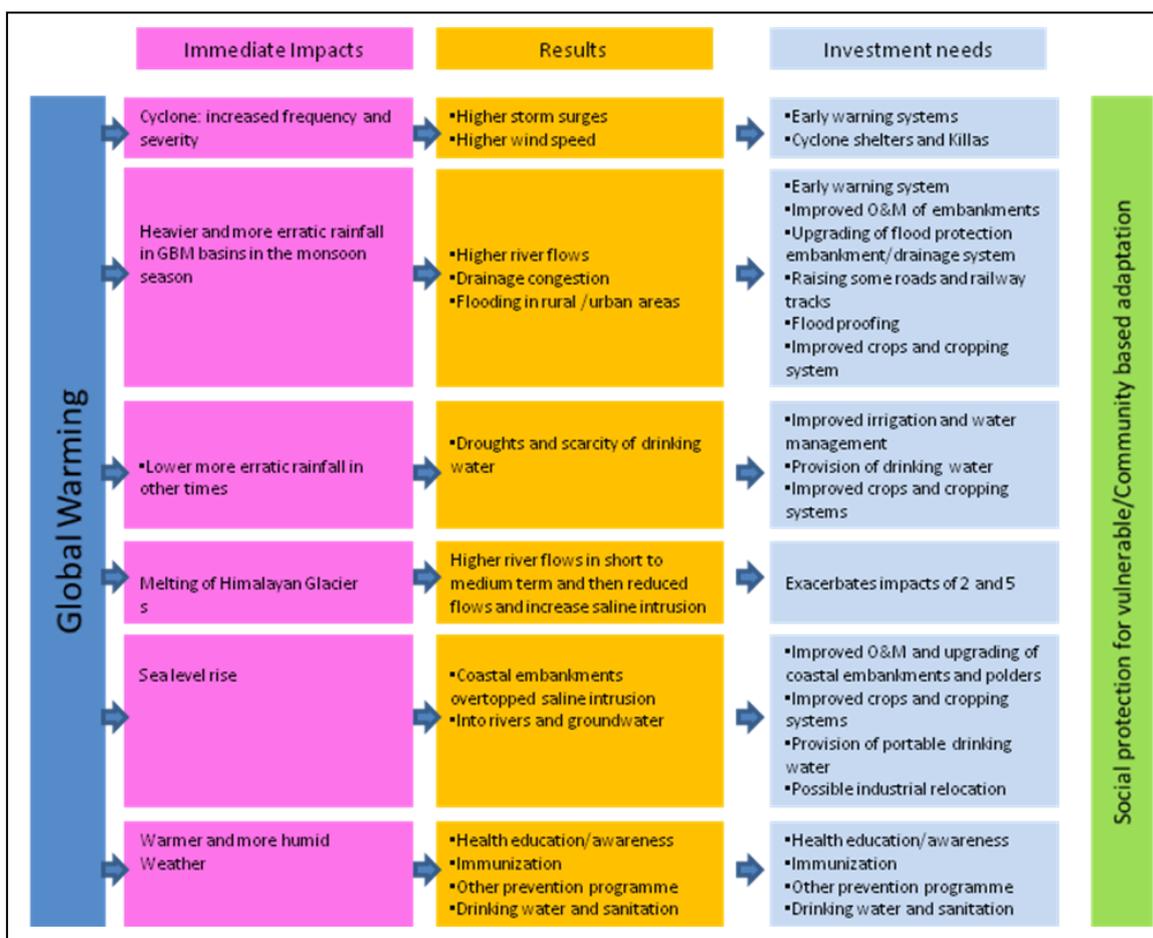
Bangladesh prepared National Adaptation Programme of Action (NAPA) in 2005 where several sectors were identified that might be potentially affected due to climate change. National Adaptation Plan of Action (NAPA) has provided a broad list of climatic parameters that might critically impact different sectors over different geographical locations of Bangladesh.

Table 1: Climate change impact and critical vulnerable area (NAPA, 2005)

Climate and Related Elements	Critical Vulnerable Areas	Resultant impact
Temperature rise and drought	North-west	<ul style="list-style-type: none"> • Agriculture (crop, livestock, fisheries) • Water scarcity • Energy • Health
Sea Level Rise and Salinity Intrusion	Coastal Area, Island	<ul style="list-style-type: none"> • Agriculture (crop, fisheries, livestock) • Water (water logging, drinking water, urban) • Human settlement • Energy • Health
Floods	Central Region, North East Region, Char land	<ul style="list-style-type: none"> • Agriculture (crop, fisheries, livestock) • Water (urban, industry) • Infrastructure • Human settlement • Health • Disaster • Energy
Cyclone and Storm Surge	Coastal and Marine Zone	<ul style="list-style-type: none"> • Marine Fishing • Infrastructure • Human settlement • Life and property
Drainage congestion	Coastal Area, Urban, South West	<ul style="list-style-type: none"> • Water (Navigation) • Agriculture (crop)

The critical region is the coastal region that presumably would be mostly affected due to climate change. Frequency of tidal surge and cyclone disrupt the development, livelihood of this region due to these disasters. Recent study also shows that the Bangladesh as a part of Bengal basin is subsiding; coastal zone is experiencing the subsidence most (in Khulna area subsidence is @ 9.55 mm/year). The problem of drainage congestions and water logging in the region is going to multiply under the climate change scenarios. Salinity intrusion is expected to increase with sea level rise therefore requires augmentation of fresh water inflows in the region during critical periods. Pre-monsoon flooding will affect North eastern and north western zone mostly. The decrease in rainfall during dry season is likely to affect the North western, southwestern and north central zone mostly which is already low rainfall zone. Population in the urban areas is expected to increase by about 40% by the year 2025; the problem water supply, sanitation, drainage and flood control is expected to increase many fold with the climate change. Existing flood forecasting and early warning systems need to be strengthened by increasing lead times and strengthening dissemination mechanisms. Multipurpose cyclone and flood shelter need to be established more as well as there should be ensure proper management of this infrastructure. Flood Zoning, Flood Insurance, adjustment of Cropping Calendar, Watershed management need to be established. Drought most commonly affects the north western region, which causes lower rainfall than the rest of the country. Initiative is required for harnessing surface water by conserving river water developing deep tube well and setting up the Barrages and also to adjust this situation in the existing cropping pattern. Recently published Bangladesh Climate Change Strategy and Action Plan (BCCSAP, 2009) also identified key climatic parameters that might affect different sectors including the investment need for adaptation and mitigation.

Figure 3: Likely impact of climate change in Bangladesh and required investments under different sector (BCCSAP, 2009)



The Strategy underlines actions to be taken under the following groups as follows:

- Flood management
- Irrigation and Drought management
- Water supply and sanitation
- Major River and Water management
- Urban drainage
- Protection of coastal areas from Storm surges and cyclone
- Erosion control measure
- Institutional development and enabling environment
- Research, information dissemination and management
- Environmental and pollution control

3. NWMP implementation Scenario and Climate Change

The National Water Management Plan prepared by the Water Resources Planning Organization (WARPO, 2004) has a total of 84 programmes under eight clusters within the principle of integrated water resources planning to be implemented by different agencies relevant to water resources management. The sub-sectoral programmers in the NWMP grouped as per BCCAS actions may be summarized below. Enter discussion on the allocation under Water supply and sanitation (Urban drainage, flood control separated), erosion control, Coastal zone protection, Research & information allocation to be discussed. Clearing House of WARPO, which is established as per national water policy (1999) to check the technical aspects of the water sector projects, brings a new paradigm in the water sector of Bangladesh. Ten points are considered in the clearing house of WARPO: (i) Whether the project is in conformity National Water Policy (ii) Whether the project is in conformity with National Water Management Plan (NWMP) framework and its Eight Clusters (iii) Examine whether the project is in conformity with the goal and objectives of the pro-poor related actions programs/projects of water resources management included in the Poverty Reduction Strategy Paper (PRSP)(iv) Whether the project has followed the Guidelines of Participatory Water Management (GPWM) and ensure that Cost recovery, Cost sharing and O&M incorporated within its plan of action(v) Whether the project is consistent with the concept of Integrated Water Resources Management (IWRM)(vi) Examine whether the project is not overlapping and duplication with any other project of other organizations or individual/ group initiatives and resolve disputes if any relating to appropriation(vii) Examine Environment Impact Assessment EIA of water sector projects(viii) Examine if important sociological issues with especial attention to poor and women are adequately addressed (SIA) (ix) Examine whether the project appraisal (feasibility studies) followed the Guidelines for Project Assessment (GPA) (x) Ensure appropriate and proven analytical procedures and evaluation methods, tools and technique are used in the project appraisal. Infact, the above mentioned ten points closely focus on the climate change impact on the water sector projects. With the changing climate, National Water Management Plan (NWMP) needs systematic updating to ensure a transparent plan for the future.

3.1 Implication of NWMP Climate Programmes

In this section How climate programme is already incorporated within existing National Water Management Plan (NWMP) is discussed. Major issues are addressed in 11 main clusters focusing climate change impact. Table 2 shows the short term (ST)(0-5 years), Medium Term (MT)(5-10years) and Long Term (LT)(10-25 years) investment scenario of NWMP climate Programme.

Table 2: Implication of NWMP Climate Programmes

Clusters of NWMP climate programmes		ST(mill. Tk)	MT (mill.)	LT (mill.)

			Tk)	Tk)
(i) Flood management	FM	7921	12284.3	73273.6
(ii)Irrigation and Drought management	IRR	1640.4	5571.3	11795.3
(iii)Rural Water supply and sanitation	R-WSS	20000	64450	93855
(iv)Urban Water supply and sanitation	U-WSS	13737.5	54200	163351
(v)Major River and Water management	MR	5648	2740	115153.1
(vi)Urban drainage	UD	10916.5	48439.6	55577.4
(vii)Protection of coastal areas from Storm surges and cyclone	CP	2576.8	5801.9	23527.7
(viii)Erosion control measure	EC	2077	5813.7	24415.2
(ix)Institutional development and enabling environment	ID	4073.7	6992.9	8211.9
(x)Research, information management	RD	715	1000	1700
(xi)Environmental and pollution control	EP	2926.1	4756.3	7940.5

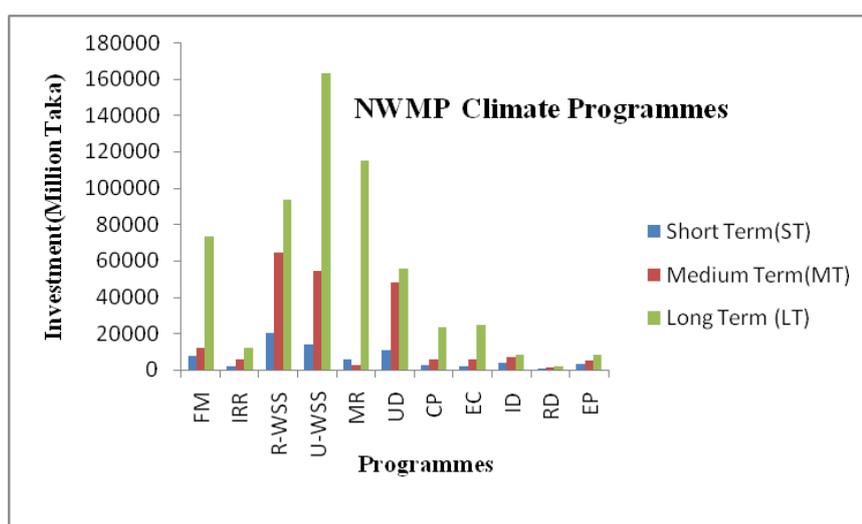


Figure 4: Strategic Investment for NWMP climate Programmes

3.2 Linkage between NWMP and Bangladesh Climate Change Strategy and Action Plan (BCCSAP)

BCCSAP provides a set of programmes under six priority action pillars: (i) Food Security, Social Protection and Health (ii)Comprehensive Disaster Management (iii) Infrastructure (iv)Research and Knowledge Management. It is a 10- year programme (2009-2018) for capacity building and country resilient to climate change challenges. First five-year part based on six themes encompasses 44 programmes related to adaptation and mitigation. On the other hand, the National Water Management Plan is set in the context of development indicators for 50 years. It is a rolling 25-year plan in three phases. The short-term (2000-05) is considered a firm plan, the medium-term (2006-10) an indicative plan, and the long-term (2011-25) a perspective plan. It's said in the plan that Implementation of the plan is monitored regularly and it will be updated every five years. NWMP identified some knowledge gaps for the future water sector development of Bangladesh.

There are many different technical issues to address in improving water resources management in Bangladesh. Significant challenges exist in dealing with such issues as river maintenance, erosion control, land accretion and

coastal zone management. Most important issues that figure out by NWMP are as follows: Understanding the full implications of climate change and developing appropriate responses, Fully understanding the sustainable limits of groundwater use and the impacts that quality has on its utility, and the long term strategic implications, Understanding the relationship between water and the natural environment and establishing key indicators and thresholds for environmental health and sustainability and thresholds for environmental health and sustainability, Assessing the current and future extent of contamination and the implications for food safety of irrigating with arsenic contaminated water and the effectiveness of treatment method for domestic water supplies, Determining the most appropriate management models for Bangladesh to follow, Assessing how best to promote private sector participation in major infrastructure development and management, Promoting dialogue amongst the co-riparian countries and developing appropriate long-term strategies for Bangladesh in response to the increasing demands on the overall system.

In this section linkage between NWMP and BCCSAP is developed to enhance the development activities considering the impact of climate change.

4. Case Study: Bhola

Coastal zone is diverse in a number of aspects from rest of the country. Three indicators have been considered for determining the landward boundaries of the coastal zone of Bangladesh. These are: influence of tidal waters, salinity intrusion and cyclones/storm surges. Out of 19 coastal districts, **Bhola** a district in south-western Bangladesh is high-flying as a coastal zone area. It is located in the Barisal Division. It is also the largest offshore island region in Bangladesh, with an area of 3403.48 km². It is bounded by Lakshmipur and Barisal districts to the north, Bay of Bengal to the south, Lakshmipur and Noakhali districts, Meghna (lower) river and Shahbazpur Channel to the east, Patuakhali district and Tentulia river to the west. Seven Upzila of this districts are Bhola Sadar Upazila, Burhanuddin Upazila, Char Fasson Upazila, Daulatkhan Upazila, Lalmohan Upazila, Manpura Upazila, Tazumuddin Upazila

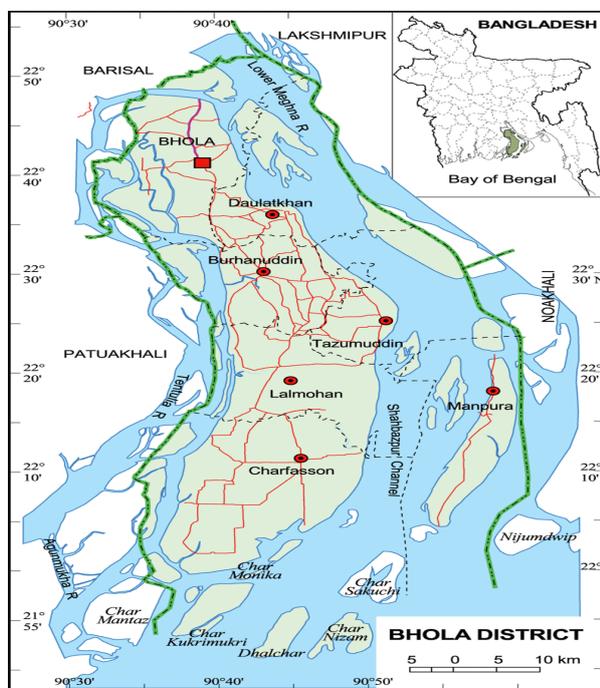


Figure 4(a) : Map Showing Bhola district

Adaptation to Climate Change Within National Water Management Plan (NWMP)		
Sub-sectors according to BCCSAP	NWMP programme	Activities in the water sector adaptive to Climate change (with no regret)
Flood management (FM)	DM 004, 005	<i>Raising national and Regional and feeder roads and railways above low risk levels</i>
	DM 003	<i>Flood Proofing in the Charlands and Haor Basin</i>
	MC 010, 012, 014, 016	<i>Dhaka, Chittagong, Khulna and Rajshahi city Flood Protection</i>
	TR 007	<i>Large and Small Town Flood Protection</i>
Irrigation and Drought management (IRR)	AW 001-006	<i>Expansion of irrigation both groundwater and surface water in public and private sector, improve efficiency of water use, cost recovery with increase participation of communities and local government</i>
	DM 006	<i>Promote supplementary irrigation during the drought-prone aman season, as well as including efforts to drought-proof rural water supplies.</i>
Rural water supply and sanitation (R-WSS)	TR 003, 005	<i>Implementation of piped water supply in town areas and provide hygienic latrines for sanitation and introduce sewerage system</i>
	TR 004, 006	<i>Provide quality water supply services and hygienic sanitation facilities to rural areas</i>
Urban water supply and sanitation (U-WSS)	MC 002-009	<i>Improve and extend water services with institutional and financial reforms, expand sanitation and sewerage coverage in the Dhaka, Chittagong, Khulna, Rajshahi city.</i>
	MC 001	<i>Asset management of water supply and sewerage system in the Major cities</i>
Major River and Water management (MR)	MR 002-005, 010	<i>Augmenting surface water availability from major Rivers through barrages and other means for multipurpose uses in SW, NW, NC and NE regions</i>
Urban drainage (UD)	TR 008	<i>Install adequate drainage system for storm water drainage</i>
	MC 011, 013, 015, 017	<i>Develop and extend the storm water drainage network in Dhaka, Chittagong, Rajshahi and Khulna city</i>
	DM 001, 002	<i>Construction and maintenance of Cyclone shelters and Killas and bari-level cyclone shelter in he char areas</i>
Protection of coastal areas from Storm surges and cyclone (CP)	AW 007	<i>Strengthening of coastal polders and inland polders</i>
	AW 008	<i>Land Reclamation and Coastal Protection and A forestation</i>
	MR 006-009, 011	<i>Undertaking implementation of dredging, river bank protection for resuscitation of rivers and khals of the regions for drainage and surface water supply and navigation</i>
Erosion control measure (EC)	ID 001-005	<i>Transfer of FCD/FCDI to local management, Local Government need assessment and capacity development and regulatory body for water supply and sanitation,</i>
	ID 006-010	<i>Strengthening of WARPO as permanent planning organization, Strengthening of DoE and expand up to district level, capacity development of DMB, capacity building for BMD for early warning, Haor board for preserving wetlands, RRI for river management and BWDB for flood forecasting and warning and monitoring water resources</i>

Adaptation to Climate Change Within National Water Management Plan (NWMP)		
Sub-sectors according to BCCSAP	NWMP programme	Activities in the water sector adaptive to Climate change (with no regret)
	EE 001-006	<i>Drafting of water laws to facilitate management water resources, testing participatory management models, prepare guidelines manual for project planning, and economic instrument for regulation</i>
	EE 010	<i>Raising public awareness, private participation, alternative Financing for water management</i>
	EE 007-009	<i>Systematic and comprehensive water sector database establishment, and undertake research for water resources and agriculture.</i>
Research, information management (R&D)	MR 001	<i>Undertaking of Studies and research for augmenting surface water availability.</i>
Environmental and pollution control (PC)	EA 001-003, 006	<i>National Pollution Control Plan and undertake clean-up of existing pollution and other specific measures</i>
	EA 004, 005	<i>Capture fisheries increase and fish friendly structures construction</i>
	EA 009	<i>Improve management in the Ganges dependent area for ecological protection in the Sunderban areas</i>
	EA 010	<i>Environmental Responsibility Public Awareness Raising and Empowerment</i>

4.1 Invested Programme in Water Sector (Bhola)

Presently 7 projects of BWDB and Small scale water sector projects of LGED is visible in the water sector of Bhola districts. Name of the projects are:(1) Construction of Embankment at Char Kukri-Mukri & River bank protection at Ghosherhat & Ramneoaz (2) River Bank Protection of Vulnerable part at Lalmohan upzila under Bhola District (phase iii) (3) Protection of Elisha-Kachia area of Bhola District from the erosion of Meghna River (4) Bhola District Town Protection (Phase –iii) (5) Charfession and Monpura Town Protection Project in Bhola District (6) Protection of Shahbazpur Gas Field from Erosion of the Meghna River under Borhanuddin Upzila of Bhola District (Phase –ii) (7) Bhola District Town Protection (Phase –ii).Major Problem Identified in Bhola are Erosion, Tidal Surge, Salinity intrusion, Flood, Cyclone, Fresh water unavailability. From the project description, we see erosion is the main threat in Bhola, although Tidal Surge, Salinity intrusion is dominating impact due to climate change.

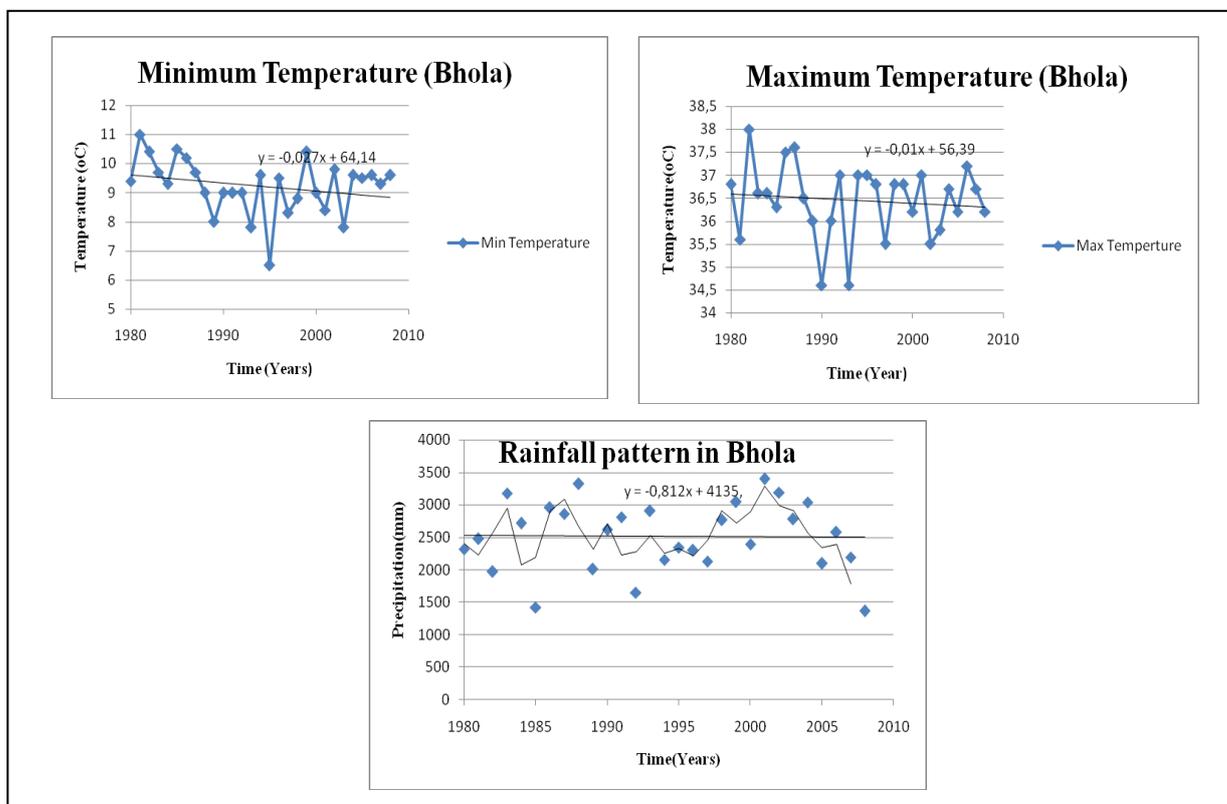


Figure 4 (b): Hydrological Scenario of Bhola District

5. Conclusion and Discussion

The main purpose of watershed management is to protect, maintain, and restore water resources in our watersheds. In order to do this, we must use proper planning and management of water resources and their uses. Upstream affects downstream. All activities that have an impact on water quality, quantity, or rate of flow at locations upstream, have impacts downstream. Because of this, watersheds are logically the most appropriate units for managing water. The watershed-based management provides a way to consider a wide range of issues along with the community's vision for the future of the watershed under a single framework. National Water Act considering the main principal of National Water Policy (1999) and Climate Change Impact could ease the process to ensure IWRM.

The programs/ projects included in the water resources of the Sixth Five Year Plan SFYP (2011-2015) would require approximate Tk.235050 million for implementation. Institutional, human resources, logistic and financial involvement for the successful implementation of the various programs are huge and need well throughout strategic and policies. Strategies SFYP plan (2011-2015) could be little step to cop up with climate change. Dredging of Rivers ,River bank protection (New),River bank protection (Rehabilitation),Construction of Embankment, Resectioning of embankment, Coastal embankment, Resectioning of Coastal embankment, Coastal Cross dam, Excavation of Irrigation canal, Re-Excavation of Irrigation canal, Excavation /Re-Excavation of drainage channel, Irrigation / Hydraulic structure, Rehabilitation of irrigation structure, Construction / Rehabilitation of flood control structures, Reservoir, Rubber dam, Barrage, Installation of pump house & rehabilitation, Formation of WMO's (in addition to e

xisting 7000 nos) are the basic output need for the immediate way forward to mingle with the nature.

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