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Yearly Newsletter 2015

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BANGLADESH NATIONAL COMMITTEE OF THE INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE (BANCID)

World Water Day 2015 was observed on Sunday, 22 March 2015 organized by BANCID under the guidance of Ministry of Water Resources in association with Bangladesh Water Development Board (BWDB), Institute of Water Modelling (IWM), Center for Environmental and Geographic Information Services (CEGIS), Bangladesh Water Partnership (BWP) and Bangladesh Agricultural Research Council (BARC)

Bangladesh National Committee of the International Commission on Irrigation and Drainage (BANCID) organized a Seminar on "Water and Sustainable Development" on the occasion of the World Water Day 2015 under the guidance of Ministry of Water Resources in association with Bangladesh Water Development Board (BWDB), Institute of Water Modelling (IWM), Center for Environmental and Geographic Information Services (CEGIS), Bangladesh Water Partnership (BWP) and Bangladesh Agricultural Research Council (BARC) at BARC Auditorium, Dhaka on Sunday, 22 March 2015.

Barrister Anisul Islam Mahmud, MP, Hon'ble Minister, Ministry of Water Resources, Government of the People's Republic of Bangladesh graced the occasion as Chief Guest. Mr. Muhammad Nazrul Islam, Bir Protik, MP, Hon'ble State Minister, Ministry of Water Resources, Government of the People's Republic of Bangladesh graced the occasion as Guest of Honour. Dr. Zafar Ahmed Khan, Secretary, Ministry of Water Resources, Government of the People's Republic of Bangladesh attended the seminar as Special Guest. The Seminar was chaired by Engr. Abdur Rob Miah, Director General, Bangladesh Water Development Board & Chairman, BANCID. Welcome address was given by Mr. Md. Jahid Hossain Jahangir, Director, Joint Rivers Commission, Bangladesh & Member Secretary, BANCID and vote of thanks was given by Engr. Abdur Rob Miah. Eminent water experts and engineers from different government and non government organizations, academicians, representatives from NGO's attended the seminar.

A special supplement containing messages from Hon'ble Minister, Hon'ble State Minister, Secretary, Ministry of Water Resources, Government of the People's Republic of Bangladesh and Director General, BWDB was published. The special supplement also contained a write up on Water Resources Management and Sustainable Development by Mr. Syed Ali Ahasan, Additional Director General (Eastern Region), BWDB. The special supplement was published in three well circulated national dailies: "The Daily Ittefaq", "The Daily Kaler Kantho" and "The Daily Star" on 22 March 2015.

Bangladesh National Committee of the International Commission on Irrigation and Drainage (BANCID)

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Yearly Newsletter 2015
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BANGLADESH NATIONAL COMMITTEE OF THE INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE

Editorial

The Publication of Annual Newsletter of Bangladesh National Committee of the International Commission on Irrigation and Drainage (BANCID) is a great initiative taken by the Study and Publication Sub-Committee of BANCID. The aim of this publication is to disseminate information on the activities of BANCID and to receive feedback from the concerned communities.

In this fourth issue of the newsletter, write ups/articles on water related issues have been included. We are thankful to the contributors/organizations for submitting the write ups/articles. We will feel very much comfortable to receive comments and suggestions from the concerned organizations on our initiative of publishing this newsletter.

BANCID Study and Publication Sub-Committee

1.	**Dr. M. Shahjahan Mondal**, Professor, IWFM, BUET	Convener
2.	**Dr. K. Azharul Haq**, President, BWP	Member
3.	**Mr. Md. Sarafat Hossain Khan**, Director General, WARPO	Member
4.	**Mr. Md. Mahfuzur Rahman**, Additional Director General (Planning), BWDB	Member
5.	**Mr. Md. Jahid Hossain Jahangir,** Member, JRC	Member
6.	**Mr. Md. Hafizullah Chowdhury**, Chief Engineer, BADC	Member
7.	**Mr. Motaher Hossain**, Superintending Engineer, Design Circle-6, BWDB	Member
8.	**Mr. K. M. Humayun Kabir,** Proiect Director, Capital (Pilot) Dredging of River System in Bangladesh, BWDB	Member
9.	**Dr. Nazmun Nahar Karim**, Principal Scientific Officer, BARC	Member
10.	**Mr. Fazlur Rashid**, Director, Directorate of Staff Development, BWDB	Member
11.	**Mr. Abu Saleh Khan**, Deputy Executive Director (Operation), IWM	Member
12.	**Mr. Malik Fida A. Khan**, Director, Climate Change Study Division, CEGIS	Member
13.	**Dr. Atikur Rahman**, Associate Professor, Department of Irrigation & Water Management, BAU	Member
14.	**Dr. Md. Ruhul Amin**, Director (Wetland), DBHWD	Member
15.	**Mr. Kazi Rezaul Karim**, Chief Scientific Officer, RRI	Member
16.	**Mr. Mohammad Alamgir**, Principal Scientific Officer (EF&F), WARPO	Member
17.	**Mr. Md. Mofazzal Hossain***,* Director, JRC and Member Secretary, BANCID	Member Secretary

From Member Secretary's Desk

ACTIVITIES OF THE BANGLADESH NATIONAL COMMITTEE OF THE INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE (BANCID)

The International Commission on Irrigation and Drainage (ICID) was established in 1950 with the objective of promoting technical, economic and social cooperation with regards to irrigation and drainage. In 1957, the ICID's mandate was extended to cover flood control and river training. Bangladesh became member of ICID in 1973. BANCID was constituted under the Ministry of Water Resources since its establishment. The members of BANCID are appointed from different organizations actively engaged in the field of irrigation, drainage, flood control, river training works and other water related activities including one representative from Ministry of Water Resources. BANCID holds national and international seminars in Bangladesh. BANCID also observes World Water Day on 22nd March every year since 1993.

On the occasion of the World Water Day 2015, BANCID organized a seminar on 22 March 2015. Two key note papers related to the theme of the Seminar "Water and Sustainable Development" were presented in the seminar, one by Mr. Abu Saleh Khan, Deputy Executive Director (Operation), Institute of Water Modelling (IWM) and the other by Engr. Md. Waji Ullah, Executive Director, Center for Environmental and Geographic Information Services (CEGIS).

Three distinguished discussants discussed on the papers presented and the theme of the occasion. The designated discussants were: (i) Dr. K. Azharul Haq, Vice President, Bangladesh Water Partnership (BWP) & Former Managing Director, Dhaka Water Supply & Sewerage Authority (DWASA), (ii) Dr. Umme Kulsum Navera, Professor, Department of Water Resources Engineering, Bangladesh University of Engineering and Technology (BUET) and (iii) Mr. Md. Mahfuzur Rahman, Project Coordinating Director, Char Development and Settlement Project-4, Bangladesh Water Development Board (BWDB). Besides, many participants took part in the open discussions and expressed their valuable comments and observations.

The following main observations and recommendations were emerged from the seminar:

1. The seminar observed that life and livelihood of the millions of people of Bangladesh have been revolving around waters of the rivers in Bangladesh over the ages. Bangladesh is the lowest riparian country of the three mighty rivers, viz, the Ganges, the Brahmaputra, and the Meghna due to its geographical location. The catchment area of these rivers is about 1.72 million sq. km. of which only 7% lies in Bangladesh. The water availabilities in Bangladesh changes significantly during monsoon and dry season. Bangladesh experiences flood during monsoon and serious water scarcity during dry season. Being lower riparian country of the Ganges-Brahmaputra-Meghna (GBM) river basin, Bangladesh has no control over its water resources and it alone cannot manage its water resources. Therefore, sustainable development of water resources of Bangladesh depends on equitable sharing and integrated water resources management of the transboundary waters.
2. The seminar noted that potentials of water resources in this region should be explored to increase food production, improve navigation facilities, fish production, riverine eco-system and overall environment of the region which would improve livelihood of the people.
3. The seminar expressed its view to give priority for constructive and meaningful dialogue with the neighboring countries in order to receive Bangladesh's equitable shares of water of the common rivers. It also recommends that necessary means and measures should be undertaken to manage the water resources of the country in a comprehensive, integrated and equitable manner and undertake essential steps for basin-wide planning for development of water resources of the international rivers.
4. The Ganges Barrage Project should be implemented on an urgent basis in order to meaningfully utilize the water of the Ganges as received under the provision of the Ganges Water Sharing Treaty of 1996 which would support various sectors like agriculture, forestry, fisheries, navigation, salinity control, ground water recharge and overall ecosystem of the Ganges dependant area in Bangladesh (about one-third of the country).
5. Projects for utilization of river water should be planned in such a manner that those do not affect the environmental flow for sustenance of river ecosystem.
6. The seminar also opined that while planning and implementing the water management projects in the coastal areas of Bangladesh, the climate change effects are to be considered for coastal land accretion, erosion, changes to shore line, sea-beach, navigability, port and harbor, wet land, safety to coastal cities like drainage, flooding, salinity, sewage and water supply etc.
7. It opined that coordinated, coherent and concerted policies and management plans should be undertaken for sustainable water resources development.
8. The seminar also recommended that there should be a collaborative platform for better coordination among the water using organizations and by this way sustainable management of water resources of Bangladesh can be achieved.
9. Rain water harvesting schemes should be implemented especially in the coastal areas of Bangladesh.

BANCID would like to express its sincere thanks to Joint Rivers Commission, Bangladesh for providing necessary fund towards publication of BANCID Newsletter 2015.

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BANCID National Committee

From its establishment in 1973, BANCID is actively involved in dissemination of research outcome and news related to irrigation, drainage, climate change and other water related issues both home and abroad. The present 18 member approved Committee (2014-2016) headed by Director General, BWDB is as follows:

1.	**Director General** Bangladesh Water Development Board (BWDB), Dhaka.	Chairman
2.	**Head** Department of Water Resources Engineering Bangladesh University of Engineering and Technology (BUET), Dhaka.	Vice Chairman
3.	**Dr. M. A. Quassem** Water Expert and Former Director General Water Resources Planning Organization (WARPO), Dhaka.	Member
4.	**Member** Joint Rivers Commission, Bangladesh (JRC), Dhaka.	Member
5.	**Director General** Water Resources Planning Organization (WARPO), Dhaka.	Member
6.	**Director General** River Research Institute (RRI), Faridpur.	Member
7.	**Director General** Department of Bangladesh Haor and Wetland Development (DBHWD), Dhaka.	Member
8.	**Executive Chairman** Bangladesh Agricultural Research Council (BARC), Dhaka.	Member
9.	**Head** Department of Irrigation and Water Management Bangladesh Agricultural University (BAU), Mymensingh.	Member
10.	**Chief Engineer** Local Government Engineering Department (LGED), Dhaka.	Member
11.	**Chief Engineer** Department of Public Health Engineering (DPHE), Dhaka.	Member
12.	**Managing Director** Dhaka Water Supply Authority (DWASA), Dhaka.	Member
13.	**Chairman** Bangladesh Agricultural Development Corporation (BADC), Dhaka.	Member
14.	**Executive Director** Centre for Environmental and Geographic Information Services (CEGIS), Dhaka	Member
15.	**Executive Director** Institute of Water Modelling (IWM), Dhaka.	Member
16.	**President** Bangladesh Water Partnership (BWP), Dhaka.	Member
17.	**Deputy Secretary (Administration)** Ministry of Water Resources Government of the People's Republic of Bangladesh, Dhaka.	Member
18.	**Director** Joint Rivers Commission, Bangladesh (JRC), Dhaka.	Member Secretary

Bangladesh Water Act 2013: Challenges and Opportunities around Policy and Institutions for the Implementation for a Sustainable Water Future

Saiful Alam, Director (Technical), WARPO

Background

Water Governance is the mechanism by which different and sometimes competing water interests can be balanced in the long-term interests of the nation's people. It is also the mechanism by which harmful activities from particular actors can be regulated, to prevent damage to shared water resources and systems. Governance is about the policies in place, about the institutions implementing those policies, and about how governance is functioning on the ground. Water governance is at the heart of how water is managed in any country.

Bangladesh Water Act 2013

The Bangladesh Water Act 2013 (BWA) is the latest and most important water legislation/policy in Bangladesh. The BWA was passed in the parliament on August 2013 and received President's assent on May 2 2013. The aim of the BWA is to create an enabling environment for the implementation of IWRM in the country, some of which are already addressed in different existing water legislations. It particularly aims to face the growing need and challenges regarding water rights, protection of water resources, water use, and water services touching the overall water management in the country.

Opportunities

The BWA has established the right to access water and integrated human rights perspective concerning provisioning of safe drinking water to all. National Water Resources Council (NWRC) is the apex body to decide about the approval of plans and policies. Executive Committee of NWRC is the principal regulator to operationalize by declaring water stress areas, sustainable limit and prioritizing the water use, ensuring normal flows in the rivers and channels, protecting water bodies, declaring water zones, flood flow zones, restricting the use of land, and controlling pollution that affects the overall sustainability of water management.

The BWA has both administrative and judicial enforcement mechanism for its implementation. Some of the provisions of enforcement are issuance of compliance, protection, removal order, imprisonment, compensation etc. The overall directives of the National Water Policy (NWP) and National Water Resources Plan (NWRP) would be implemented through the 'clearing house' role of WARPO. The overall strategy for its implementation would be to coordinate the approaches (by different sectors) in an integrated manner to balance competing interest, reduce damages of shared water resources and its system for the longer term interest of the country.

Challenges

The Water Act 2013 is broadly a strong policy. However the difficult part for its implementation would be to integrate and coordinate the efforts from different agencies and ministries. There are altogether 13 ministries with 35 departments that are responsible for the development of water resources. Lack of coordination among these institutions is the main hindrance to manage the water resources. As secretariat to Executive Committee of the National Water Resources Council (ECNWRC), the overall responsibility lies with WARPO to implement the BWA and monitor all the activities related to the water sector. Because of its positioning, WARPO has difficulty in coordinating the activities of all the activities under different ministries. The Ministry of Environment & Forests has acted as the principal water monitor with authority to take legal measures against various water polluters, particularly industries which need an integrated approach with the use of water. As per the Environment Conservation Act (ECA) 1995 and the Environment Conservation Rules (ECR) 1997, the Department of Environment (DoE) shall give clearance to Environmental Impact Assessment (EIA) to any project while Water Act 2013 states that WARPO should give clearance to any kind of water related project. The two approaches should be a one stop service through some mechanism to be detailed out.

The Ministries of Agriculture (MoA), Local Government, Rural Development & Cooperatives (MoLGRD&C), Industries (MoI), Textiles & Jute (MoT&J) are the other principle water users apart from the Ministry of Water Resources that has serious stake for the sustainable use of resources. WARPO itself has no real implementation powers, therefore arrangements are required if ECNWRC (WARPO) should really work for the enforcement of the BWA. There is no specific provision for getting implementation support from the law enforcement authority and the Ministry of Home Affairs (MoHA).

The Department of Textile (DoT) currently approves Effluent Treatment Plant (ETP) setup for textile facilities, but does not have extensive monitoring powers. Responsibility for ETP system monitoring lies with the DoE. This creates a contradiction. Either the DoT should take responsibility for regular monitoring, or the ETP approval process should sit with DoE. The relevant government authorities should resolve such conflicts as ETP management has a direct linkage with reduction of water pollution.

In order to implement at local level, decentralization of some authority may be made so that the enforcement matters be A coordinated by the District Committees, Upazila Committee under Local Government with support from local implementing agencies e.g. BWDB, BADC, LGED, Municipality.

Although the Coastal Zone Policy 2005 addressed the coordination among the institutes, there is lack of cooperation among the Bangladesh Navy, DoE, Ministry of Shipping (MoS) and Department of Forest (DoF) to control the coastal environmental pollution. Specific focus on the coordination between the concerned organizations would strongly benefit implementation of the policy as well as control the coastal environmental pollution. Land zoning or local multi-stakeholder dialogues could be used to create mechanisms for resolving land use conflicts, especially in the coast.

Last but not the least, to ensure good water governance, institutions need a variety of resources and capacities, sound knowledge and capacity on scientific and technical matters, availability of modern and appropriate technologies, skilled manpower for effective execution, sufficient funds and equitable financial allocation, appropriate institutional infrastructure, and transparency and accountability.

Recommendations

1. A clear positioning of WARPO, its set up with clear specification of power, man and machine is required for enabling the enforcement of BWA;
2. Decentralization of power to the local implementation would be required;
3. Ministry of Industries (MoI) needs to be fully included for enforcement of industrial pollution;
4. Ministry of Land (MoL) needs to be coordinated well to enforce the encroachment of water bodies;
5. There are substantial challenges around monitoring for improved monitoring of groundwater extraction and ETP functionality;
6. Penalties for non-compliance are too low to be effective;
7. Increased, visible community engagement and in the follow up mechanisms required;
8. Agricultural water impacts are in need of stronger regulation and awareness raising;
9. Industrial bodies should be incorporated into water governance mechanisms and government support options explored for ETP and Central Effluent Treatment Plant (CETP) investment;
10. Subsidies, incentives need to be included for the enforcement of rules for industrial effluent discharge and agricultural water uses;
11. A fully independent regulator may be established for urban water supply and sanitation.

Conclusions

There are a number of laws/policies that overlap or connect with BWA, e.g. Environment Conservation Rules 1997, Water Body Conservation Act 2000, National River Protection Commission Act 2013, Local Government Act 2009, Water Supply and Sewerage Authority Act 1996, Disaster Management Act 2012, Coastal Development Strategy 2006, Coastal Zone Policy 2005, etc. which need harmonization in detailing the act for implementation. BWA is a framework act to be elaborated through drafting rules. A draft rules (BWR) has been prepared recently by WARPO harmonizing the other important laws. WARPO is collaborating with Swiss Development Corporation (SDC) in Barind area (five upazilas of Rajshahi and Chapai Nawabganj) for the implementation of BWA at local level.

Minor irrigation development activities in southern part under Integrated Agricultural Productivity Project (IAPP) through BADC

Md. Zafar Ullah, Superintending Engineer, BADC

Bangladesh Agricultural Development Corporation (BADC) is one of the pioneer organizations in agricultural sector. It supplies 3 major inputs to the farmers for crop production, such as quality seed, fertilizer and irrigation since 1961. Irrigation plays vital role for crop production. During the last 4 decades, the annual food production of the country has been increased by more than three and a half times by increasing Boro, T-aman and vegetables. Boro rice is entirely irrigation dependent. It alone contributes more than 55% of the total cereal production in Bangladesh. It indicates that the country's agricultural development is mainly based on the development of irrigational facilities.

Now-a-days irrigation activities are facing some problems due to unplanned withdrawal of ground water (the static water level declined beyond suction limit during March-April) and shortage of surface water flow during dry season. Due to climate change, sea level rises, saline water intrudes and siltation of river bed occurs. These are the main constraints for future irrigation development.

To overcome these problems, the govt. has already taken decision about increase of surface water development. The potential areas for surface water development are hoar area, southern belt and other low lying water bodies in Bangladesh.




Barisal, Jhalokathi, upper part of Patuakhali and Borguna districts have enough fresh tidal water flows through Modhumoti, Shondha, Kirtonkhola, Biskhali, Dhansiri, Boleshor, Tetulia and Paira river system almost throughout the year, but most of the canals/khals are filled with silt, making difficulties for farmers to lift water by low lift pump (LLP) during low tide in dry season (January-March).

Shortage of fresh water in dry months leads to scarcity of drinking water and disrupts other normal household activities such as feeding livestock, cooking, washing, bathing etc. To overcome these problems govt. has taken an integrated agricultural project in southern region named Integrated Agricultural Productivity Project (IAPP). It is foreign aided project funded by Global Agriculture and Food Security Program (GAFSP) and The World Bank is the supervising entity.

IAPP has four components: (a) Technology Generation, (b) Technology Adoption, (c) Water Management and (d) Technical Assistance and Capacity Building. These components are implemented by 8 agencies. BADC is implementing the water management component.

It was designed to expand scope and efficient use of surface water for increasing crop production by re-excavation of silted canals, ponds and also to meet the scarcity of drinking water and household consumption by installation of rain water harvesting storage tank in Barisal, Jhalokathi, Patuakhali and Borguna districts.

The main objectives of IAPP's water management components are: (1) To produce additional food grains through optimum utilization and consumptive use of surface water for irrigation by re-excavating canals, ponds, water bodies and applying modern irrigation technologies, (2) Installation of rain water harvesting storage tank for drinking and household consumption and (3) To increase irrigation efficiency and reduce crop production cost.

Project Achievement

The project period was 5 years out of which 4 years have already passed. By this time about 80% of water management activities have been completed. Up to June 2015, achievement scenario of water management component in southern part are: (a) expansion of irrigated area - 18000 ha, (b) increase in food production - 72000 MT, (c) construction of subsurface irrigation water distribution line - 208 km, (d) re-excavation of khash canal - 93 km, (e) re-excavation of pond - 90 nos., (f) irrigation efficiency increase - 10% and (g) construction of rain water harvesting storage tank with tin shed - 1020 nos., which ensured drinking water of 7 lakh liters per year.

Impact Evaluation

The World Bank mission visited the southern region and put their valuable opinion on water management component in Aide Memoire during October 27 - November 5, 2015: "The mission visited one buried pipe scheme and one canal re-excavation site. Consistent with the finding of previous mission, the economic impact of these interventions has been strong. For the buried pipe scheme, irrigable area has increased by 50%, the supply of water has improved and yield per ha has been up by 20%. For the canal re-excavation the results are even more impressive. Irrigable area has increased by over 100%, plus farmers have been able to add an additional crop and in some cases two additional crops per year as a result. The water user groups (WUGs) in both cases are functioning well, with savings accounts opened and member contributions covering the costs of regular system maintenance."

The mission also writes up in Aide Memoire about drinking water that "Scarcity of sweet water in the coastal region is an acute problem of the communities. The project under BADC component includes installation of rain water harvesting storage system at the household level for supplementing consumption of sweet water for the coastal people. Harvesting rain water supplements access to drinking and cooking water, while surface water in ponds is used for water feeding and washing the cattle heads."

Besides these, the inter-ministerial monitoring and evaluation committee also visited the project area. Their comments were: "Installation of rain water harvesting storage tank in Kalapara upazila under Patuakhali district is the most effective work to remove scarcity of drinking water. So this activity may be expanded."

Mr. Sugata Talukder from the World Bank visited Patuakhali and Borguna districts to observe and monitor IAPP project especially the BADC component e.g. re-excavation of ponds and canals and rainwater harvesting storage tank. Among of those visited activities, he mentioned in his report about Purba Kokua Para canal re-excavation scheme which passed through three different villages at Amtali upazila under Barguna district that ''Before re-excavation of canal, the villagers were able to cultivate only one crop (Aus rice) and rest of the time the land was inundated. Now farmers are able to cultivate at least in two cropping seasons (watermelon and other vegetables). These canals usually cover more than 2000 acres of land across three villages, so if we consider only one more season to be cultivated in a year, then the villagers get benefits of more than BDT 20 million (1 acre yields 20 mond X Tk. 500 = Tk. 10000) per year."

Conclusion

The project has changed cropping pattern, increased crop production, irrigation efficiency and supplemented drinking water among beneficiaries of the project areas. Experience of this project may be applied for other southern districts of Bangladesh.

Potentialities of growing upland crops in saline areas of Satkhira district using surface water and groundwater

Dr. Nazmun Nahar Karim, Principal Scientific Officer, Agricultural Engineering Section
Natural Resources Management Division, BARC

Introduction

Satkhira district is in the southwest coastal area of Bangladesh where prevalence of salinity is very much. Millions of hectares of arable land are affected by varying degrees of soil salinity. The factors which contribute significantly to the development of saline soil are: tidal flooding during wet season (June-October), direct inundation by saline or brackish water and upward or lateral movement of saline groundwater during the dry season (November-May) and willful inundation with brackish water for shrimp farming. During the wet season, salinity goes down due to onset of monsoon. In this time, farmers in the coastal area usually grow T. aman rice. After the harvest of T. aman, soil is still muddy as flood/tidal surge water recedes late from the crop field. For this reason, traditional land preparation is not possible for Rabi crops sowing. In the month of January, some farmers cultivate local variety of boro rice and get yield half to two metric tons per hectare. Rests of the lands remain fallow during the Rabi and Kharif-I seasons due to excess soil salinity and lack of adequate irrigation water. Cropping intensity in the region is thus much lower compared to other areas of the country. Considering the importance of the problem, this research work aims to find the potentialities of using surface water and groundwater for increasing yield, through the introduction of upland semi-salt tolerant different crops (sunflower, soybean and maize) during fallow period, November to June which will help increase agricultural production and cropping intensity in the saline areas of Satkhira district.

Approaches and Methodologies

To achieve successful crop production and increase cropping intensity in the saline areas, three on-farm experiments with low water demanding and semi-salt tolerant crops (viz. sunflower, maize and soybean) were set at farmers' field located at Kharibila village, Satkhira Sadar, Satkhira near irrigation sources (canal water and groundwater) during 2010-11 and 2011-12. One crop was allocated to four selected farmers and irrigation treatments (no irrigation, canal water and groundwater irrigation) which remained same for all the crops. Cultural practices were followed as were recommended for the crop varieties. Irrigation treatments were followed as per soil moisture condition, weather condition and growth stage of the crops. For economic analysis, the cost items were classified as: cost of human labor, using tractor and power tiller, seeds, fertilizers, cow dung, pest management, irrigation, tools and equipment, land use and interest on operating capital. All cost was charged at the prevailing market price on cash payment basis. Land use cost was estimated for the total cropping period of sunflower, maize and soybean. Gross return from sunflower, maize and soybean was calculated as the sum of the return from grain yield and by product. Net return was obtained by deducting all cost (variable and fixed) from gross return. Benefit cost ratio (BCR) was estimated as the ratio of gross return to total cost per ha.

Results/Outputs:

Sunflower

Using canal water and groundwater as a source of irrigation water, there was no significant seed yield differences and water use efficiency. Highest Electrical conductivity (EC) of canal water and groundwater was observed 4.63 & 7.86 and 5.51 & 6.09 dS/m during the growing period of sunflower of 2010-11 and 2011-12 (Table 1), respectively. Highest salinity was observed at the top soil (6.16 dS/m) followed by 15 cm soil depth (2.90 dS/m), 30 cm soil depth (2.02 dS/m) and 45 cm soil depth (1.70 dS/m) and top soil (5.84 dS/m) followed by 15 cm soil depth (4.07 dS/m), 30 cm soil depth (2.42 dS/m), 45 cm soil depth (2.01 dS/m) and 60 cm soil depth (1.81 dS/m) during 2010-11 and 2011-12, respectively. Soil salinity was decreased with the increase of soil depth. Benefit cost ratio was 1.86 & 1.70 and 1.74 & 1.83 using irrigation water from canal and groundwater during 2010-11 and 2011-12, respectively.

Table 1: Salinity of soil and irrigation water, depth and number of irrigation, water requirement, seed yield, water use efficiency and benefit cost ratio of sunflower during 2010-11 and 2011-12

Year	Sources of irrigation water	Soil salinity (dS/m)	Irrigation water salinity (dS/m)	Depth and number of irrigation (cm) & (nos.)	Water requirement (cm)	Seed yield (kg/ha)	Water use efficiency (kg/ha/cm)	Benefit cost ratio
2010-11	Canal water	Up to 6.16	2.64-4.63	8 (3)	15.89	2880.00	181.28	1.86
	Ground water		5.22	8 (3)	18.19	2611.00	143.57	1.70
2011-12	Canal water	Up to 5.84	0.93-7.86	9 (3)	12.42	2821.00	227.13	1.74
	Ground water		4.32-6.40	9 (3)	12.42	2954.00	237.84	1.83

Maize

Highest cob yield was obtained as 6370 kg and 9610 kg using canal water and groundwater as a source of irrigation water during 2010-11 and 2011-12, respectively. A non significant difference was observed in water use efficiency with variable sources of irrigation water (Table 2). Maize crop received four irrigations during 2010-11 and three irrigations during 2011-12. Highest Electrical conductivity (EC) of canal water and groundwater was found to be 4.33 & 8.00 and 5.53 & 6.94 dS/m during the growing period of maize. Soil salinity was 6.86, 3.88, 1.98 & 1.71 dS/m and 6.08, 3.59, 2.93, 2.07 & 2.03 dS/m in the top soil followed by 15, 30, 45, & 60 cm soil depth during 2010-11 and 2011-12, respectively. Soil salinity was decreased with the increase of soil depth. Benefit cost ratio was 2.32 & 1.94 and 2.34 & 1.70 during 2010-11 and 2011-12, respectively.

Table 2: Salinity of soil and irrigation water, depth and number of irrigation, water requirement, cob yield, water use efficiency and benefit cost ratio of maize during 2010-11 and 2011-12

Year	Sources of irrigation water	Soil salinity (dS/m)	Irrigation water salinity (dS/m)	Depth and number of irrigation (cm) & (nos.)	Water requirement (cm)	Cob yield (kg/ha)	Water use efficiency (kg/ha/cm)	Benefit cost ratio
2010-11	Canal water	Up to 6.86	2.64-4.33	11 (4)	34.08	6240	183	2.32
	Ground water		5.22-5.33	11 (4)	33.19	6370	192	1.94
2011-12	Canal water	Up to 6.08	0.93-8.00	9 (3)	32.33	9610	297	2.34
	Ground water		4.32-6.94	9 (3)	32.91	8380	255	1.70

Soybean

Highest seed yield was obtained as 1610 kg and 2000 kg using groundwater and canal water as a source of irrigation water during 2010-11 and 2011-12, respectively. A non significant difference was observed in water use efficiency of soybean using variable sources of irrigation water (Table 3). Soybean crop received 3 irrigations each during 2010-11 and 2011-12. Highest Electrical conductivity (EC) of canal water and groundwater was found to be 4.33 & 5.53 and 7.86 & 6.94 dS/m during the growing period of soybean. Soil salinity was 3.00, 2.94, 2.12 & 1.70 dS/m and 7.07, 5.66, 3.26, 2.25 & 1.90 dS/m at the top soil, 15, 30, 45 & 60 cm soil depth during 2010-11 and 2011-12, respectively. Soil salinity was decreased with the increase of soil depth. Benefit cost ratio was 1.39 & 2.35 and 1.42 & 2.28 during 2010-11 and 2011-12, respectively.

Table 3: Salinity of soil and irrigation water, depth and number of irrigation, water requirement, seed yield, water use efficiency and Benefit cost ratio of soybean during 2010-11 and 2011-12

Year	Sources of irrigation water	Soil salinity (dS/m)	Irrigation water salinity (dS/m)	Depth and number of irrigation (cm) & (nos.)	Water requirement (cm)	Seed yield (kg/ha)	efficiency (kg/ha/cm)	Benefit cost ratio
2010-11	Canal water	Up to 3.00	3.19-4.33	10 (3)	18.40	1575.00	86.00	1.39
	Ground water		5.22-5.38	10 (3)	18.83	1610.00	86.00	2.35
2011-12	Canal water	Up to 7.07	1.48-7.86	9 (3)	24.52	2000.00	82.00	1.42
	Ground water		5.36-6.94	9 (3)	27.24	1944.33	71.00	2.28

Conclusion

Two years' field results reveal that irrespective of past yield and prevailing soil and water condition of Satkhira district, sunflower, maize and soybean crops create an opportunity of inclusion of a new crop in the saline area (Fig. 1). Sunflower, maize and soybean crops can be disseminated for cultivation in Satkhira district where canal water and groundwater salinity is up to 8.00 and 6.94 dS/m, respectively and soil salinity is up to 7.00 dS/m. Certainly it will increase food production and strengthen farm economy. Along with this, it will also help maintain natural balance through optimizing maximum use of irrigation water.

Fig 1: Achievements in establishing alternative crops (sunflower, maize and soybean) in Satkhira district

Assessment of Drainage Performance of the Selected Coastal Polders under CEIP-I using Mathematical Modelling

Md. Nazibur Rahman, Executive Engineer, JRC

Introduction

Drainage study using the state-of-the-art mathematical modelling is a trusted means of investigating the effectiveness of drainage plans and its potential impacts on the physical processes. It can also assist to establish the existing drainage patterns of a drainage basin and help identify the future problem that might continue due to the implementation of the potential drainage improvement interventions. As such, mathematical model study has been carried out for the Coastal Embankment Improvement Project (CEIP) to assess the drainage performance of selected polders for existing and climate change condition. Total 17 polders have been selected for improvement under Phase-I of CEIP, out of which 5 priority polders (P-32, P-33, P-35/1, P-35/3 and P-39/2C shown in Figure 1) are already under implementation in accordance with the findings of drainage model studies. The existing calibrated and validated Southwest Regional Model has been used as the basis of drainage model for this study.

Figure 1: 5 Priority polders of CEIP

Mathematical Model

A two-dimensional model of the Bay of Bengal and one-dimensional model for the rivers in the coastal areas have been used for the drainage study. The Bay of Bengal model has been used to generate the downstream boundary of the river model, whereas the propagation of tide in the rivers and floodplain are modelled using the river model. The South West Region Model has been developed using two separate modules of MIKE 11 modelling system of DHI Water and Environment; rainfall-runoff model (hydrological model, MIKE11-NAM) and hydrodynamic model (MIKE11-HD).

Rainfall Runoff Model (NAM)

Rainfall Runoff Model is applied to estimate the runoff generated from rainfall occurring in the catchment. The model takes into consideration the basin characteristics including specific yield, initial soil moisture contents, initial ground water level and irrigation/abstraction from the surface or ground water sources. The catchments of the rainfall runoff model are delineated according to the topographic barriers/watershed boundaries, roads and river networks.

Hydrodynamic (HD) Model

The hydrodynamic model calculates the discharge and water level using the runoff generated from the catchments (output of rainfall runoff model) as well as taking input of flow from the upstream rivers. The southwest region model is a complex network of tidal and non-tidal river systems, which covers the entire southwest region of Bangladesh. This model comprised of 252 river branches.

Boundary Conditions of Hydrodynamic Model of Southwest Region

Boundary condition basically represents the hydrodynamic influence of the river networks outside the model domain. Hence, for reliable presentation of nature within the model setup, accurate boundary condition is a fundamental requirement for development of hydrodynamic model. The hydrodynamic model of the southwest region contains a total of 41 boundaries, of which 29 are upstream and 12 are downstream boundaries. Through the upstream boundaries, fresh flows from the Ganges and Padma River enter into the river networks of the southwest regional model. On the other hand, the saline water enters into the river networks of the southwest region with tide from the sea through the downstream boundaries. Two types of downstream boundaries are generated for the drainage study. The boundary for the existing condition is prepared using the observed tidal level at sea and tidal constituents; and the boundary for climate change condition which includes sea level rise phenomena. A typical generated downstream boundary for existing and sea level rise condition used in the model set-up is shown in Figure 2.

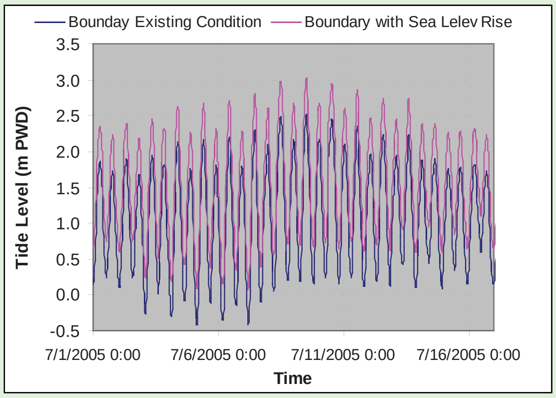

Figure 2: Typical downstream boundary for Existing and Climate Change Condition

Development of Polder Drainage Model

Polder drainage model has been developed incorporating surveyed cross-section data of the internal drainage channels under the project and existing water control structures within the polder area including detailed catchments distribution for the internal drainage channels and peripheral river systems. The structures have been entered properly with their dimensions and invert levels in the model set-up together with their operating rules i.e. if the outside water level is higher than that of polder water level, the gates of the structure would automatically be closed and vice versa. Within the polder, the runoff generated from the catchment is routed into the respective drainage khals in proportion to their respective drainage areas which eventually drained towards the peripheral khals through the structures.

Options for model simulation

The following options were devised for investigation:

a) Existing drainage system without climate change (Base condition)
b) Existing drainage system with climate change (Option 1)
c) Modified drainage system with climate change (Option 2)

Model simulations and Assessment of Drainage Performance

Model Simulation

The drainage model has been simulated separately for the base condition and climate change condition for the above mentioned options.

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Assessment of Effectiveness of Existing Drainage System under Base Condition

The drainage performance is evaluated in terms of flood inundation depth of the polder area (land classification) based on model result. Using the model results and available Digital Elevation Model (DEM) of the study area, flood depth maps for 3 day duration showing the area of different classes of land (F0, F1, F2 & F3) are prepared as given in Table 1 for 5 priority polders. A typical flood map is shown in Figure 3. The analysis indicates that most of the polders in existing condition (without climate change) comprise flood free and F0 land (productive land). This means that there is no drainage congestion problem in these polders under base condition.

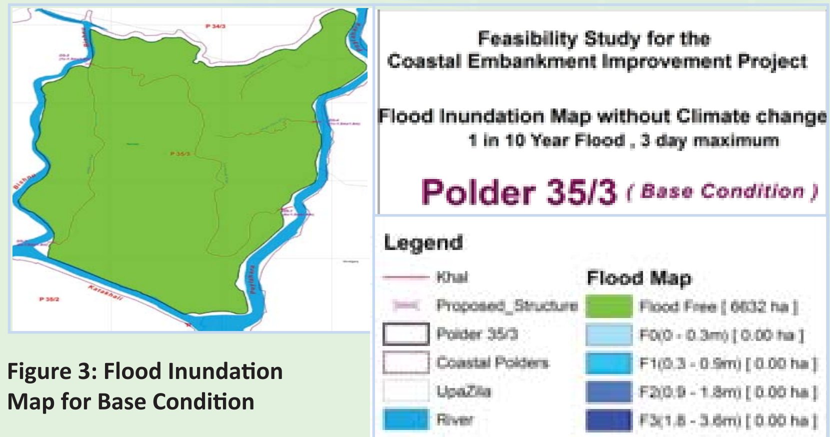


Figure 3: Flood Inundation Map for Base Condition

Table 1: Land classification of 5 priority polders for Base (existing) Condition

Land Classification	P-35/1		P-35/3		P-32		P-33		P-39/2C	
	Area under 3-day WL (Ha)	% of Total Area	Area under 3 -day WL (Ha)	% of Total Area	Area under 3 -day WL (Ha)	% of Total Area	Area under 3 -day WL (Ha)	% of Total Area	Area under 3 -day WL (Ha)	% of Total Area
Flood Free	14502	99.88	6632	100	2943.25	50.13	10165.25	99.89	11085	99.71
F0 (0 < to 0.30m)	16	0.11	-	-	2739	46.65	10.75	0.11	22	0.19
F1 (0.30 < to 0.90m)	2	0.01	-	-	188	3.20	-	-	10	0.09
F2 (0.90 < to 1.80m)	-	-	-	-	1	0.02	-	-	-	-
F3 (> 1.80m)	-	-	-	-	-	-	-	-	-	-

Assessment of Drainage Performance under Climate Change Condition

For assessment of impact of climate change on drainage performance of the drainage networks, model simulation has been carried out considering climate change-induced parameter (rainfall, sea level rise). The rainfall has been increased by 26% for the months of March, April and May and 13% for the months of June, July and August in accordance with 4th IPCC (Intergovernmental Panel on Climate Change) report. In addition, 50 cm sea level rise has been increased in the downstream boundaries for model simulation. Using the model results, flood depth map has been prepared. The results of model study for different options are given in Tables 2 & 3. A typical flood depth map under climate change condition for 3-day duration maximum water level is shown in Figure 4.

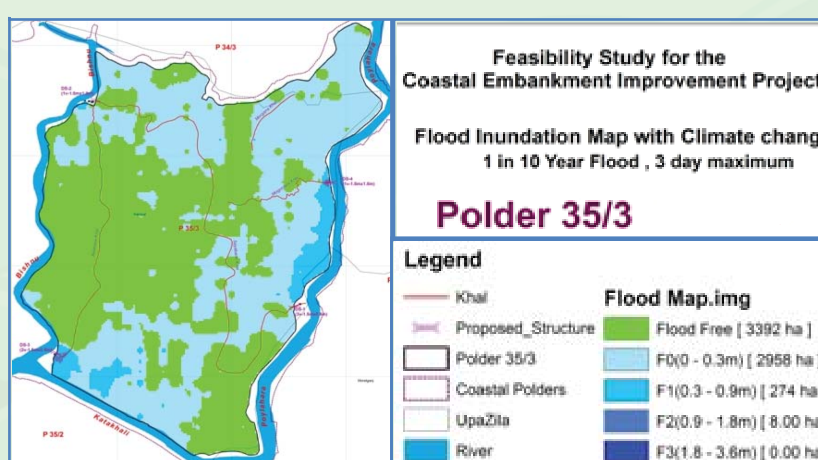


Figure 4: Flood Inundation Map for Climate Change Condition

Table 2: Land Classification of 5 priority polders for option 1 (Climate Condition)

Land Classification	P-35/1		P-35/3		P-32		P-33		P-39/2C	
	Area under 3 - day WL (Ha)	% of Total Area	Area under 3 - day WL (Ha)	% of Total Area	Area under 3 - day WL (Ha)	% of Total Area	Area unde r 3 - day WL (Ha)	% of Total Area	Area under 3 - day WL (Ha)	% of Total Area
Flood Free	12405	85.44	6630	99.97	5837.5	99.43	9968	97.97	10297	92.63
F0 (0 < to 0.30m)	1978	13.63	3	0.03	29.75	0.51	198	1.93	807	7.25
F1 (0.30 < to 0.90m)	135	0.93	-	-	4.0	0.07	11	0.10	13	0.11
F2 (0.90 < to 1.80m)	1	0.01	-	-	-	-	-	-	-	-
F3 (> 1.80m)	-	-	-	-	-	-	-	-	-	-

Table 3: Land Classification of 5 priority polders for option 2 (Climate Condition)

Land Classification	P-35/1		P-35/3		P-32		P-33		P-39/2C	
	Area under 3 - day WL (Ha)	% of Total Area	Area under 3 - day WL (Ha)	% of Total Area	Area under 3 - day WL (Ha)	% of Total Area	Area under 3 - day WL (Ha)	% of Total Area	Area under 3-day WL (Ha)	% of Total Area
Flood Free	10466	72.09	6144	92.65	5821.25	99.15	8735	85.83	6358	57.19
F0 (0 < to 0.30m)	3881	26.73	487	7.34	45.25	0.77	1414	13.89	4268	38.39
F1 (0.30 < to 0.90m)	172	1.18	1	0.02	4.75	0.08	28	0.28	490	4.41
F2 (0.90 < to 1.80m)	1	0.01	-	-	-	-	-	-	1	0.01
F3 (> 1.80m)	-	-	-	-	-	-	-	-	-	-

Findings of Drainage Model

From the drainage model study described above, the following conclusions are made:

- The performance of existing drainage network and hydraulic structures are satisfactory for most of the 5 priority polders;
- There would be no significant drainage congestion under climate change condition with 1 in 10 flood event for polder 35/1;
- The impact of climate change on flooding would be significant in polder 35/3;
- Some of the existing structures need to be rehabilitated/replaced depending on the actual condition;
- Silted up drainage khals should be excavated.

Climate Change Impacts on Coastal Bangladesh: Where We Stand as an Adapting Society

Debanjali Saha, Lecturer, IWFM, BUET

The coastal region of Bangladesh is susceptible to various natural disasters due to its geographical location and certain other characteristics. Moreover, global warming induced climate change is an alarming issue for the inhabitants of the coastal region. Though, Bangladesh is not a major contributor of the global greenhouse gas emissions, but the impacts on this region are much higher than most of the other countries of the world. According to the IPCC fifth assessment report, climate change is likely to further aggravate the natural disasters in Bangladesh. Under these circumstances, adaptation is the only viable option and the most prominent choice for dealing with climate change. A large number of potential adaptation options have been formulated in

Bangladesh and among them a lot have already been implemented and practiced. This analysis is based on the adaptation practices in response to climate change impacts in the coastal region of Bangladesh which have been documented as an adaptation inventory for the international collaborative project: Deltas, vulnerability and Climate Change: Migration and Adaptation (DECCMA) with financial support from the UK Government's Department for International Development (DFID) and the International Development Research Centre (IDRC), Canada. Almost 110 adaptation practices have been found in the coastal region, some of which started about 30 years ago, while some other are quite recent practices. These include both physical-technological-infrastructural and socio-economic measures. According to a developed protocol of the aforementioned project, the evidences of currently observed and documented adaptations were collected from different published literatures by searching in a number of sources.

Analyses of the Adaptation Practices

Based on some evaluation criteria including geographical location, sectors of adaptations, providers and beneficiaries of the adaptations, stresses and shocks in response to which adaptations are taken, sustainability issues and barriers to the adaptations and gender dimension of the adaptations, these coastal adaptations were analysed. In terms of geographical location of the adaptations, it can be observed that, exterior coastal districts experienced more adaptations than the interior districts. Khulna and Satkhira districts are found to experience the highest number of adaptations. This occurred due to the fact that, these areas face all types of natural disasters and both governmental and non-governmental organizations have large number of awareness raising activities here to deal with the impacts of the disasters. This has made the local people more concerned and adaptive in recent times.

Coastal embankment construction and rehabilitation, stress tolerant agricultural crop varieties, suitable water supply facilities, disaster management by capacity building and knowledge dissemination, etc., are the major adaptations in the coastal region. Among all these, agriculture sector is found to experience the highest number of adaptations followed by the water resources management sector (Figure 1). This indicates that, Bangladesh being an agrarian country is much aware of the impacts of climate change on agriculture and food security and is trying to adapt with the changed future scenario for better agriculture and livelihood opportunities.

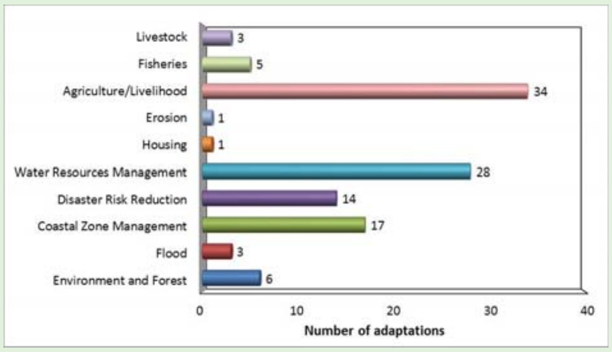


Figure 1: Sectoral distribution of the adaptation practices

Government sector is the major provider of the adaptation measures in the coastal region followed by the non-governmental organizations (NGOs). Almost 63% of the coastal adaptations are provided by different ministries, government organizations including Bangladesh Water Development Board, Bangladesh Rice Research Institute, Bangladesh Agriculture Research Institute, Local Government Engineering Department, Comprehensive Disaster Management Programme, other government agencies, etc. NGOs like Bangladesh Rural Advancement Committee, Care Bangladesh, Practical Action, Oxfam International, etc., are also involved with various small and medium scale adaptations. The local communities of the targeted area are reported to be the beneficiaries of these adaptation measures in the coastal region among which farmers, fishermen, disaster affected and vulnerable people, women, children and disadvantaged groups are the majority.

The adaptation practices in the coastal region have evolved in response to long term chronic stresses like salinity, drainage congestion, regular flood, water scarcity, etc., or any sudden shocks like large flood, cyclone, tidal or storm surge, etc. From Figure 2(a), it can be observed that, highest percentages of the coastal adaptations that have been taken in response to different stresses go to salinity followed by regular flood. In Figure 2(b), the adaptations taken in response to sudden shock are classified. Climate change is considered as a major shock, as half of the adaptations are taken in response to climate change. These include heat tolerant crop variety in response to future temperature increase, research activities using crop models for innovation of climate resilient crop varieties, height raising of coastal protection works to deal with high intensity storm surge and flood events, etc.

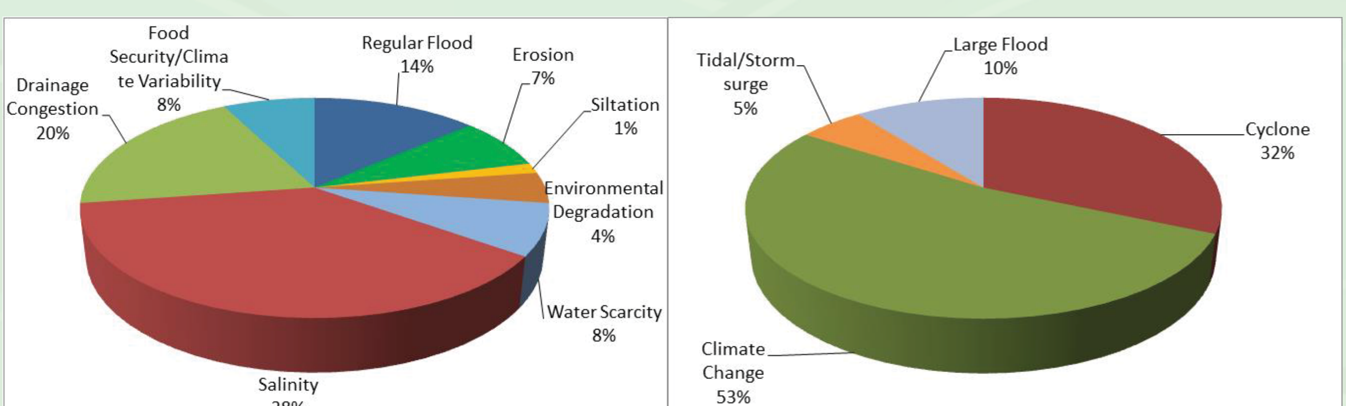


Figure 2: Percentage of adaptations taken in response to (a) chronic stresses and (b) sudden shocks

Long term sustainability is a major requirement for the success of any adaptation measure. According to the major criteria of sustainability i.e., high public acceptance, cost effectiveness and high rate of return, suitability for the users, easy operation and maintenance, environmental friendliness, etc., about 64% of the adaptation measures are found to be sustainable in the long run. But due to some barriers which include lack of access to resources and lack of capital as major ones, sustainability and effectiveness of these adaptations may be hampered. Figure 3 represents the barriers faced by the adaptations in the coastal region. Also, most of the adaptations are not adequately gender sensitive which obstructs the main success concept of the adaptations. Alleviating the barriers by sufficient government support, proper coordination among the responsible organizations and good governance can ensure the success and sustainability of the adaptations for the sake of safety and betterment of the coastal community. Also, ensuring gender sensitivity is a prior requirement for improving the socio-economic condition of the coastal community under future changed climate. These measures can establish Bangladesh as a significant adapting society in the 21st century of global development and urbanization.

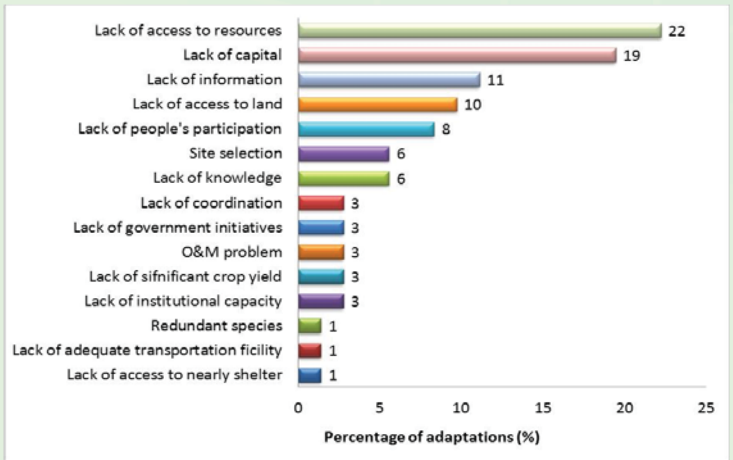


Figure 3: Common barriers faced by the coastal adaptation measures

Restoring the rivers through Capital Dredging

K. M. Humayun Kabir, Proiect Director, Capital (Pilot) Dredging of River System in Bangladesh, BWDB

Bangladesh is a great delta formed by the alluvial deposits of the Ganges, the Brahmaputra and the Meghna (GBM) river systems. The GBM system drains about 1350 billion m3 of water from a total catchment area of about 1.72 million km2. The discharges carry a sediment load of about 1.1-1.2 billion ton annually. Out of 57 trans-boundary rivers, 54 enter from India and the remaining 3 from Myanmar. Bangladesh has no less than 405 big and small rivers which mostly act as drainage arteries for the monsoon months.

Though the country receives a huge influx of water during the monsoon (June-October), the discharges dwindle drastically during lean part of the year (November-May). The economy of the country, which has evolved around water (being predominantly agrarian), critically hinges on the annual water cycle from scarcity to over abundance. Acute scarcity of water during the lean season severely affects agriculture, fisheries, navigation and above all environment.

River bed siltation/aggradation is pronounced in Bangladesh due to transport of huge sediment with low topographic gradient. Because of alluvial nature of soils, the morphology is dynamic and the river planform is unstable.The problems faced by the country can be briefly summarized as, rivers' conveyance capacities are decreased by siltation when it could no longer accommodate the full flow and overspill their banks causing frequent floods, river banks suffer from erosion resulting in loss of land and off-takes of the distributaries get choked. Sustainable river management has become an important issue because of these devastating effects. The National Water Policy also stressed the dredging and river training works for sustainable river management in Bangladesh.

To restore the navigability of the rivers, increase the drainage capacity and mitigate river bank erosion, the Government of Bangladesh has given importance on capital dredging work. But Bangladesh has lack of adequate practical experience and insufficient study on capital dredging. Before implementation of capital dredging of major river system in Bangladesh, the total dredging volume required needs to be assessed and the implementation process for sustainability of capital dredging work must be ascertained. For this reason "Capital (Pilot) Dredging of River System in Bangladesh (CDRSB)" project has been formulated to gain experience. This project consists of Capital Component and Study Component.

Objective of Capital Component

a. Dredging of the Jamuna river from upstream of Sirajganj Hard Point (through Bangabandhu Bridge) to near Dhaleswari Offtake: To divert the flow from the west channel into a mid-channel to reduce the risk of failure of Sirajganj Hard Point and to guide the flow along the middle of the existing char through the Bangabandhu Bridge to near Dhaleswari Offtake. It will reduce the risk of riverbed scour along the Sirajganj hard point and also reduce the erosion of right guide bundh of Bangabandhu Bridge.

b. Dredging of Jamuna river at Nalini Bazar near Bhuapur-Tarakandi Embankment: To protect the existing Bhuapur-Tarakandi road embankment by diverting the flow through dredging of the river Jamuna near Nalini Bazar, which is the only road communication between Jamuna Fertilizer Factory and other districts of the country.

c. Land Reclamation from the river Jamuna: To reclaim land by depositing the dredged material and constructing cross bars on the low land adjacent to the river bank at upstream and downstream of Sirajganj Hard Point. This reclaimed land will be the extension of Sirajganj district and will be developed for the public and private use. This land reclamation process will exhibit as a pilot scheme and if this process appears flourishing and cost effective, further land reclamation project will be taken through river/sea dredging.

Objective of Study Component

Sustainable River Management: The main objective of the study for Sustainable River Management is to find out a fifteen-year investment plan. The study will be composed of capital dredging, river training works, sustainable maintenance dredging module, spoil management, afforestation, navigation, land development, fisheries development, environmental management plan and monitoring etc. for sustainable river management. The specific objectives of the study are to devise river management plan of major rivers and distributaries for flood and erosion management, to improve navigability and to augment dry season flow in the distributaries considering capital dredging and river training works. This strategy and action plan will identify the conceptual framework on capital dredging with flood & erosion management, explore financial options and formulate conditions for implementation.

Capital Component and its Impact

Under capital component, the dredging work in the river Jamuna was carried out by national and international contractors. From FY 2010-11 to 2013-14, dredging of river Jamuna near Sirajganj Hard Point (SHP) was done in various locations under this project. Due to the construction of a closure/cross bars, a live channel along the west bank at downstream of SHP became dead and a new channel is now propagating along the char where the dredging is executed. It is seen that the dredged channel is gradually silted up but the conveyance area is increased by eroding the char area. It is a positive impact which is reducing the erosion near west bank of the Jamuna river adjacent to Sirajganj Hard Point area. But it is observed that due to high re-siltation in dredged channel, the section of the river has to be maintained regularly to guide the river flow within the dredged channel and necessary river training works/bank revetment works shall have to be provided over vulnerable locations of the river. In this connection, 4 cross bars were constructed with the dredged spoil by dumping the dredged materials near river bank while implementing the dredging work in the year 2012, 2013 and 2014. This facilitated in reclaiming valuable land of about 16 sq. km. formed by siltation at upstream and downstream of cross bars and developing for public use. But these cross bars had been threatened by the on rush of the Jamuna river during flood. So, necessary protective work is now under construction to safeguard the cross bars from grasp of the mighty Jamuna river and thereby to protect the reclaimed land.

Project Progress: Study Component

Under study component, Feasibility Study of Capital Dredging and Sustainable River Management in Bangladesh (FSCD&SRMB) had been carried out by national and international consultants. Under this study 24 major rivers named (1) Atrai, (2) Ganges, (3) Ghagot, (4) Teesta, (5) Dudhkumar, (6) Dharla, (7) Brahmaputra-Jamuna, (8) Hurasagar, (9) Tongi Khal, (10) Padma, (11) Old Brahmaputra, (12) Sitalakhya, (13) Juri, (14) Dhanu, (15) Dhalai, (16) Bhogai-Kangsho, (17) Manu, (18) Karnafuli, (19) Dakatia, (20) Titas (Narsingdi Sadar–Bancharampur), (21) Meghna (Upper), (22) Ghasiakhali, (23) Madaripur Beel Route, and (24) Lower Meghna have been studied.

Outcome of the Study

In the Final Report, consultants have prepared a 15-year Investment Plan for dredging of all the major rivers and land reclamation programs. They also mentioned that for sustainability, dredging has to be a continuous process and training work/bank revetment work shall have to be provided over vulnerable locations along the dredging alignment. In addition to this, they strongly recommend to carry out rigorous analyses incorporating technical aspects, environmental aspects, global warming and their impacts, socio-economic aspects, topo-bathymetric evaluation of the river basin, planform analyses, mathematical modelling in conjunction with physical modeling etc. before implementing any interventions like dredging or such other activities on major rivers through detailed engineering study. In the proposed 15-year investment plan, the consultants suggested that around 2000 km of rivers should have to be dredged amounting 36,356 million cubic meter of earth work which will cost around 9017 billion taka. 690 km of river training work is proposed to be implemented and for this purpose, 551 billion taka will be needed. By implementing these works, 5,52,556 ha of land could be reclaimed from the rivers market value of which is 1784 billion taka.

Flood Forecasting and Warning Services in Bangladesh

Engr. Md. Amirul Hossain, Director, Planning-1, BWDB

Background

The importance of the flood forecasting and warning services (FFWS) is widely recognized as a vital non-structural measure to aid mitigation or minimization of the loss of lives, crops, properties and inconveniences due to floods. The Flood Forecasting and Warning Centre (FFWC) under Bangladesh Water Development Board (BWDB), established in 1972, prepares and disseminates flood early warnings 7 days a week during May-October in monsoon and April-May in pre-monsoon. The flood forecast is intended to alert the agencies, people, authorities, community etc. of the locality about the predicted water level (WL) of floodwater 5 days (deterministic) or 10 days (probabilistic) ahead of its occurrence with reliable accuracy for better preparation and minimizing or mitigating flood damages. FFWC is the national focal point for flood early warning.

Development of FFWS

- 1972: FFWC Established
  - ➢ Real time flood monitoring at 10 stations/points
  - ➢ Flood forecast at 6 points by gauge-to-gauge correlation
- 1992: MIKE11-FF Model Introduced
  - ➢ FF at 16 points/locations
- 1995-96: MIKE11 Super Model with GIS for flood mapping
  - ➢ FF at 30 points/locations with lead time up to 2 days
- 2000-04: Strengthening FFWS
  - ➢ FF areas coverage expanded to Central, North-west & North-east part and flood monitoring covered entire country
  - ➢ Improved accuracy and extended lead time up to 3 days
  - ➢ Improved dissemination
- 2005-07: Probabilistic FF up to 10 days introduced at 18 points
- Till 2009: Further extension of FFWS
  - ➢ FF at 38 locations on 21 rivers up to 3 days of lead time
  - ➢ Inundation mapping
- From 2012-15: Strengthening and Improvement of FFWS
  - ➢ FF at 54 locations on 29 rivers extended lead time up to 5 days
  - ➢ Structure based FF for 4 selected projects
  - ➢ Flash FF and guidance for north east and south east up to 48 hours (2 days)
  - ➢ Improved and more user friendly web site
  - ➢ Mobile based dissemination through Interactive Voice Response (IVR) by calling a number 10941, Voice Message Broadcast (VMB) by sending recorded voice message and SMS in Bangla
  - ➢ Data communication and data gathering through SMS instead of phone call
  - ➢ Flood bulletin twice instead of once a day

Data Collection

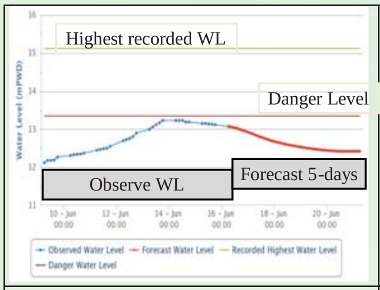
WL data for river network at designated gauge point is recorded five times daily at 3-hourly intervals during day time from 6:00 am to 6:00 pm. Rainfall is recorded daily at 9:00 am. Gauge Readers send WL and rainfall data by SMS through mobile phone. The data collections at FFWC are usually completed by 09:30 AM. WL of limited number of points of upper catchment in India and China are received at FFWC for flood forecasting purpose. Daily weather data (observed and forecast/prediction) are also collected from freely available web sites of BMD, IMD, RIMES, NOAA etc.

Data Processing and Model Simulation

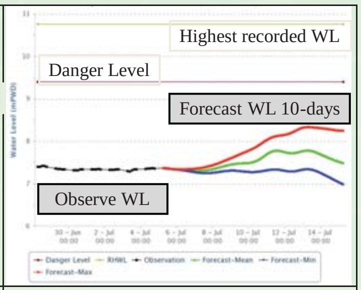
WL and rainfall data are received from the gauge points in a mobile at FFWC by SMS. Using Mobile Apps, the received data is transferred to PC, then processed and checked for validity and consistency. Processed data are then transferred as input for the “Super Model” used for generation of flood forecast at FFWC. After preparation of the boundary condition, the model is run for generating WL (or flood) forecast. The Super Model covers about 82,000 sq.km. of the country, sub-divided into 107 sub-catchments, 195 river branches, 207 link channels and few structures. The total river length under the model is about 7300 km.

Flood Bulleting and Warning Message Preparation

Daily flood bulletin is prepared with WL monitoring for 85 locations, rainfall monitoring for 59 locations and FF for 54 locations. Monitoring part of the flood bulletin indicates the present and change of WL and measured rainfall to a particular location/station. Forecast part indicates FF up to next 5 days deterministic and up to 10 days probabilistic WL of a particular point. Above/below status of WL with respect to danger level at a particular point/ location is also indicated in the bulletin. Brief Flood Warning Message with indication of rising/falling trend is prepared and presented in the summary sheet.



Up to 5 days deterministic forecast hydrograph at Sirajganj on the Jamuna river, issued on 16 June 2015



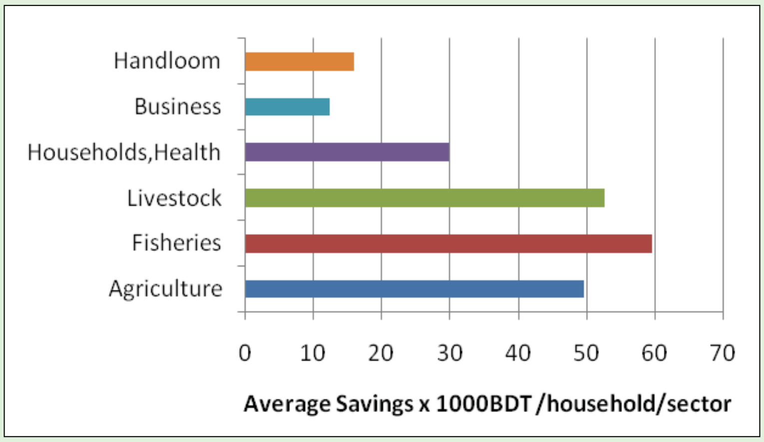
Up to 10 days probabilistic forecast hydrograph at Aricha on the Jamuna river, issued on 5 July 2015

Dissemination

Flood bulletin is disseminated by printed hard copy, telephone, email, fax, Interactive Voice Response (IVR) (by calling a number 10941), Voice Message Broadcast (VMB) (by sending recorded voice message to mobiles), SMS, lobby display and also uploaded to the website. The bulletins are disseminated to different ministries, offices (central & district level), agencies, media, interested individuals, development partners, NGOs, research organizations, gauge readers etc. Brief text message is sent through mobile phone to the policy level and to the gauge readers for local level dissemination. Professionals of the FFWC continuously interact/respond to the ministries, news media, agencies and interested persons during the flood season.

The principal outputs are the daily flood bulletin, flood map, rainfall distribution map, annual and special flood reports along with different graphical and statistical presentations during the monsoon season.

FFWS enable the communities to be prepared for the upcoming WL situation rising or falling resulting in savings of properties and reducing inconveniences due to flood. Figure shows sector wise savings by utilizing the flood early warning, where the fisheries, livestock & agriculture sectors have experienced the more savings.



Conceptual basis for environmental/instream flow requirements

Fazlur Rashid, Director, Staff Development Directorate, BWDB

The term ‘environmental flow’ has come into common usage. It applies to releases from dams which are specifically for environmental benefit. To others, it can be any flow which achieves an environmental benefit, or the flow at the end of a river system, or any flow event which should be protected. To some people, an environmental flow is the water regime provided within a river, wetland or coastal zone to maintain ecosystems and their benefits where there are competing water uses and where flows are regulated.

The conventional approach to water resource management sees water resources as being important primarily for the volume of water that can be abstracted and supplied to users to meet off stream demands such as those for urban water supply, irrigation and industrial development. What this approach does not normally take into account is that the commodity aspect of water is only one part of a complex ecosystem, which includes an ***aquatic component (streams, rivers, wetlands, groundwater) and a terrestrial component (the land and soils over or through which the water flows).*** Ecosystems provide much more benefits than just water. In particular, if the aquatic ecosystem is healthy and functional, human can enjoy benefits through an array of ecosystem goods and services.

So, environmental flow requirements may be defined as the flow regime required in a river to achieve desired ecological objectives as well as the survival of the river itself.

There are two primary ways in which environmental flow can be expressed:

- either as the volume and quality of water that must remain in a river, watercourse or water resource at specific points in the resource to maintain a particular desired level of aquatic ecosystem health; or
- as the volume of water that may be abstracted from specific points in a river, watercourse or water resource and the magnitude of change in water quality that may be allowed in a river, watercourse or water resource for aquatic ecosystem health to be maintained at a particular desired level.

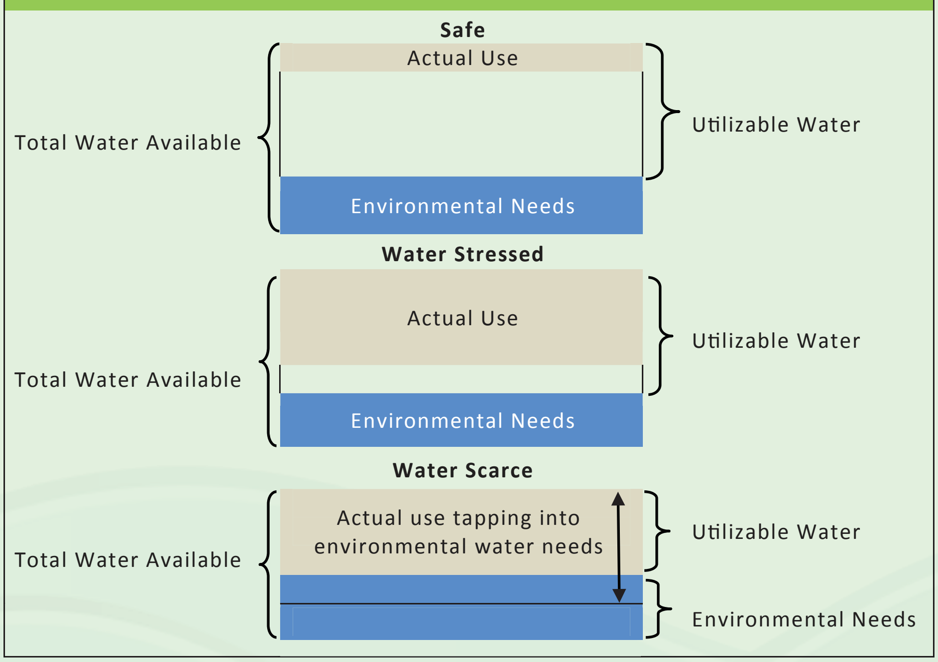
In general, environmental flow requirements are expressed in relative terms, as the proportion of the virgin or present day flow that must be maintained, or that may be abstracted, and the allowed deviation from natural or background water quality conditions. The aim in both cases is the same – to protect aquatic ecosystems as well as to keep sustenance of rivers.

How much water must be left in the ecosystem? This approach is suited to situations where water utilization is already fairly high, possibly even tending to the over utilization of water resources in the basin, and to fairly well regulated systems, where major abstractions are made from dams or weirs rather than run-of-river, and where scheduled releases can be made from flow control structures to meet environmental flow requirements. The determination of environmental flow requirements then establishes the conditions that must be achieved in the river or water resource for flow and water quality, and establishes the limits of utilization that can be allowed, through the following relationship:

Total allowed abstraction = total virgin flow – environmental flow requirements

The following figure may ease the visualization of the whole matter.

Visualizing Environmental Flow requirements with Status of Water



Challenges for Environmental Flow Requirements:

Managing run-of-river abstraction

Implementing environmental flow requirements can be especially challenging in an unregulated river basin where most abstraction is run-of-river. There may be little or no opportunity to compensate for abstraction by making dedicated releases from a dam for the downstream ecosystem. In this case, abstraction has to be managed, controlled and monitored in order to ensure that the environmental flow requirement is met.

Efficient and effective implementation of environmental flow requirements requires integrated planning at the river basin level. The sites of dams, weirs and flow control structures relative to the main stream of the river must be considered.

Dams, weirs and flow-control structures

Most dams, weirs and flow control structures are built to store and deliver water to places where it is not usually found in one season or another. In the design phase of large dams, it is necessary to determine the environmental flow requirements, particularly the peak flood flow rates, to ensure that the dam can deliver the required flows at the required times.

Groundwater abstraction and base flow

In many perennial rivers, dry season flows may be maintained largely or solely by inflows from groundwater or from the water stored in the soils of river banks. Excessive abstraction of groundwater through wells or boreholes in the riparian zone or close to a river may cause dry season flows in the river (known as base flows) to be reduced or to stop altogether.

In determining environmental flow requirements, some indication should be provided of how much abstraction of groundwater can be allowed in the riparian zone or near the river without compromising base flow in the river.

Water quality management

Water quality management strategies should be linked to the determination of environmental flow requirements.

Water sharing negotiations

If water sharing agreements are to be put in place, environmental flow requirements will be necessary prior to the start of negotiations. The achievement and implementation of a water sharing agreement depends on:

- Alignment of policy, legislation and regulation requirements for the implementation of environmental flow requirements in each basin state;
- Design and execution of a baseline monitoring program to provide the data necessary for a medium to high confidence determination of environmental flow requirements;
- Capacity building for the determination and implementation of environmental flow requirements;
- Actual determination of the environmental flow requirements for the basin;
- Design and installation of an appropriate gauging network to provide information for long-term management of the basin; and
- Institutional development within each basin state.

Salient Features of Bangladesh Haor Master Plan

Md. Nurul Alom, Deputy Director, DBHWD
Mohammad Nazmul Ahsan, Deputy Director, DBHWD

Haor is a wetland located in the North Eastern part of Bangladesh which is physically a bowl shaped shallow depression. It is a mosaic of wetland features including rivers, streams, irrigation canals, large lowland areas, seasonally flooded cultivated plains and deep beels. Haor people in Bangladesh failed to keep pace with the modern civilization and are facing so many problems. In terms of mainstream socio-economic development initiatives, they are becoming increasingly marginalized.

The constitution of the republic of Bangladesh has pledged a special attention to the disadvantaged community such as the haor people. Bangladesh Government formulates master plan for haor areas to give proper attention and development of this area. Given the special features in haor areas, an effective implementation of the Master Plan is needed to ensure the rights to essential services of the haor people. Haor Master Plan has three Volumes and twenty one Annexes. All the volumes are now open for all and available at www.dbhwd.gov.bd.

The north eastern region of Bangladesh covering 1.99 hectares of area with 19.73 million people has 373 haors/wetlands located in seven districts i.e. Sunamganj, Sylhet, Habiganj, Moulvibazar, Netrokona, Kishoreganj and Brahmanbaria. To develop the haor region, a master plan was made to gain the comprehensive understanding on the present situation. The Department of the Bangladesh Haor and Wetland Development (DBHWD) wants to put attention to preserve, protect and restore the ecosystem and save the people of the haor area from climate change effects, natural disasters and to improve their livelihood. The plan targets the Vision 2021, seventh five year plan and the other relevant polices and plans of the Government of Bangladesh.

The haor master plan was formed on the basis of optimal utilization of natural and human recourses for the next 20 years (up to fiscal year 2032). It has emphasized on flood management, environmental sustainability, production of crop, fisheries and livestock, expansion of education, settlement and health facilities, road communication, navigation, water supply and sanitation, industry, forestation, tourism, use of mineral resources and generation and power energy. The haor master plan proposes 154 development projects (Table 1) for the short, medium and long term basis on the following development areas.

Table 1: Proposed cost of development projects by development area in haor master plan

Development Area	Number of project s	Estimated cost (in Lac Taka)	Contribution
Transportation	15	516,277	18.41%
Fisheries	22	504,423	17.99%
Power and energy	4	340,989	12.16%
Forest	6	246,504	8.79%
Mineral r esources	3	215,500	7.68%
Agriculture	20	203,897	7.27%
Water r esources	9	178,374	6.36%
Health	16	120,363	4.29%
Biodiversity and Wetland	10	113,000	4.03%
Water s upply and Sanitation	2	105,000	3.74%
Livestock	10	76,694	2.73%
Industry	9	72,717	2.59%
Education	7	71,975	2.57%
Social s ervice	6	15,600	0.56%
Pearl c ulture	1	10,000	0.36%
Housing and Settlement	1	9,100	0.32%
Tourism	13	3,892	0.14%
Grand Total	**154**	**2,804,305**	**100.00%**

The DBHWD has taken 15 development projects as a part of haor master plan implementation. Other nine organizations of different ministries took 25 development projects from haor master plan for implementation from 2012 to 2031 with estimated cost of 280430.5 million taka in different locations of haor areas. The proposed development projects are to be financed either by the government from its own resources or by external support. Public-private partnership could come forward to implement the initiatives which may be private or commercial in nature.

Hybrid Modelling Approach in RRI for Water Resources Development: Using Physical and Numerical Modelling

Md. Alauddin Hossain, Principal Scientific Officer, RRI
Mohammad Mehedi Hasan, Scientific Officer, RRI

Introduction

Bangladesh is a flat deltaic region having most complex river system in the world and it is also an agrarian country. Eighty percent of the people derive their livelihood from agriculture which plays a vital role in our national economy. Bangladesh suffers from severe flooding, bank erosion and storm surges in almost every year, which is straining our economy extensively. River bank erosion is utmost important national issue in Bangladesh. The rate of erosion (cultivated land) along the Jamuna is 2000 ha per year which permanently displaces more than 20,000 people every year. Due to climate change impacts, 1% increase in peak discharge will cause25% increase in erosion. In the Padma River 10% increase in maximum discharge will cause the same rate of increase in riverbank erosion. Our development systems are hindered frequently and agricultural activities are threatened unanimously in consequence of severe flooding, bank erosion, sedimentation in river bed and tropical cyclone. River bank erosion mitigation is very complicated and price worthy process both in technical and financial aspects. In these deteriorating circumstances, to overcome the situation in a sustainable manner as well as to protect crops, land from flooding and riverbank erosion, it is essential to construct various hydraulic structures such as embankments, spurs, groynes, sluice gates, barrages, dams, bridges and river training works.

River problems are very complicated and require extensive scientific investigation, research and study in order to arrive at correct solution before actually taking up a project or scheme, which is generally very costly. Research plays a significant role in improving quality of lives of the people and also the socio-economic development of the country. Quick and effective decision making by proper use of information contributes for the uplift of the society. Researches in the field of hydraulics, geo-technical and environmental engineering carry a great importance in the development of water resources of the country. The researches, investigations and studies on river and other hydraulic problems result in economizing and sustainability of the different projects of water resources development and guard against wastage of huge expenditure. Having considered the aforementioned situation, the Government of Bangladesh established RRI as a Statutory Public Authority under the Ministry of Water Resources in 1990 by an ordinance (Act 53) in view of devising plans and actions to develop water resources of Bangladesh in a sustainable manner. As per the act, RRI has a mandate for both physical and numerical (mathematical) model studies to achieve the following objectives.

1. To carry out studies for design supports in river training, riverbank protection, flood control, irrigation & drainage works and to conduct research in river engineering, sediment control, estuary and tidal effects by means of physical model.
2. To conduct mathematical model studies on river flow & regional flow network, hydrology, surface & ground water utilization and environmental issues with special attention to salinity intrusion & water quality with a view to develop the water resources.

The overall research activities of RRI have been performed through 2 directorates namely Hydraulic and Geo-technical Research Directorates. Hydraulic Research Directorate has been conducting physical modeling of river, estuarine and coastal problems in Bangladesh to support design works of various water resources projects since its establishment in 1948. The main area of research where this directorate is directly involved are: river bed and bank protection, scouring at river training and bank protection works, bridge piers and abutments, sedimentation in the channel, dredging optimization, morphological changes etc. The existing physical facilities for conducting physical model studies are quite capable to carry out 5-6 model studies per year.

Recently RRI has been conducting hydrological and morphological study using mathematical modeling since 2007 after receiving mathematical modeling hardware and software under SICT (Support to Communication and Information Technology) Project through Planning Commission, Government of Bangladesh. Therefore, RRI is equipped with mathematical model facilities together with physical modeling facilities. It is expected that RRI will play vital role in the water sector as well as in other related sectors to make the project cost effective and sustainable. Now-a-days, mathematical modeling has become a very useful tool for research and studies and for the sustainable development of water resources. Its use is extending day by day in water sector all over the world. It is worth mentioning that these two modeling techniques are complementary to each other and for more realistic results, hybrid approach is the best. Both physical and mathematical models have been proved to be very essential for sound engineering judgments to find out solutions for different water resources development projects. In view of this, RRI is trying to adopt hybrid modeling approach by using physical as well as mathematical modeling to improve the understanding of different water systems which may lead to save time, safe and less expensive solutions for engineering problems.

RRI has already completed a number of Hydrological and Morphological Studies using mathematical modeling as the following:

1) Detail Engineering Design of Kurigram Irrigation Project (South Unit),
2) Wazed Miah Bridge on Karatowa River at 27th km of Sadullapur-Pirgonj-Nawabgonj Road under Rangpur Road Division,
3) Proposed Bridge at 72nd km of Mymensingh-Goffargaon-Toke Road under Mymensingh Road Division,
4) Proposed Bridge on Kalni River and approach road at proposed Sunamganj-Madanpur-Derai-Sullah-Ajmiriganj-Habiganj under Habiganj Road Division,
5) Proposed Boga Bridge over the river Lohalia at 14th km of Lebukhali-Bauphal-Golachipa-Amragachia Road under Patuakhali Road Division,
6) Different bridges across Pagla-Jagannathpur-Raniganj-Aushkandi Road under Sunamganj Road Division,
7) Proposed Nalua-Baherchar Bridge over the river Pandab-Paira at 28th km of Barishal (Dinerarpool)-Laxmipasha-Dumki Road under Patuakhali Road Division.

Recommendations

It is necessary to formulate strategic plan to engage RRI with the different national water resources development activities via its existing modeling tools and facilities. Under such circumstances, RRI will have scope to develop its research personnel on-the-job training in the relevant fields. However, Government's intension is as much as use of RRI's services as a statutory public authority. To do this in practice, it is needed that Government takes strong step to incorporate Physical or Mathematical Model study or both including Geotechnical Test provision in Development Project Proposal (DPP) of any water resources development project taken by the different ministries (such as ministry of communication, ministry of shipping, ministry of local government, rural development & cooperative etc.) including ministry of water resources (MoWR) of the government. Through this model study it is possible to predict about effectiveness of the design parameters of the structures and stability of the project before implementation of any project, where only 1% or 2% money of the total project is needed to conduct the model study. There is opportunity to modify design parameters in the model study if needed.

Now client is interested to perform mathematical modeling study due to the factor that it takes less time (2-3 months), whereas physical modeling study takes much time (2 times of mathematical modeling study). RRI has only one DONGLE for one user and now RRI is quite capable to carryout Hydrological and Morphological study using Mathematical modeling for different Hydraulic structures. Institutional Development and Capacity Building needs for RRI provided more DONGLE and ancillary equipments (such as Server, LAN, IPS for uninterrupted power supply, Laptop for each scientist, high power computer, printer etc.) through which scientist would develop their capacity building and RRI would develop as a self-earning institute under the Ministry of Water Resources.

Youth Engagement: An essential part of effective water management & climate resilience

Mukta Akter, Executive Secretary, BWP

Bangladesh is one of the most climate vulnerable countries of the world. Climate changes and its impacts have been showing alarming adverse effects on safe water resources. But, safe drinking water is the basic right of every citizen and is vital for improving health and in alleviating poverty. In adopting the Millennium Development Goals (MDGs), countries had pledged to reduce by half the proportion of people without access to safe drinking water by 2015.

According to the Fourth Assessment Report of IPCC, South Asia is the most vulnerable region of the world to face the climate change impacts. The international community also recognizes that Bangladesh ranks high in the list of most vulnerable countries on earth. Bangladesh's high vulnerability to climate change is due to a number of hydro-geological and socio-economic factors that include: (a) its geographical location in South Asia; (b) its flat deltaic topography with very low elevation; (c) its extreme climate variability governed by monsoon which results in acute water distribution over space and time; (d) its high population density and poverty incidence and (e) its majority of population being dependent on crop agriculture which is highly influenced by climate variability and change. It will create new negative impacts in almost all sectors, in addition to complicating and intensifying those existing problems (Abu Hassan et al. 2012). Despite the recent strides towards achieving sustainable development, Bangladesh's potential to sustain its development is faced with significant challenges posed by climate change. It is, therefore, of utmost importance to disseminate and educate about climate change impacts and mitigation among school students. The National Adaptation Programme of Action (NAPA) is prepared by the Ministry of Environment and Forest (MoEF), Government of the People's Republic of Bangladesh as a response to the decision of the Seventh Session of the Conference of the Parties (COP7) of the United Nations Framework Convention on Climate Change (UNFCCC). Inclusion of climate change issues in curriculum at secondary and tertiary educational institution is under consideration (MoEF, 2005).

Youth are the most powerful agents of change, and studies have found that many students can be extraordinarily resilient on the face of significant challenges. Providing children with empowering and relevant education on disasters and climate change in a child-friendly school environment can reduce their vulnerability to risk while contributing to sustainable development for their communities. Goodman et al. (2011) suggest REDD (Reducing Emissions from Deforestation and Forest Degradation) projects as a critical strategic opportunity. They recommend school based integrated educational approaches which empower young people to build better future through life-sustaining values, practical skills and knowledge (HEART, 2013). Successful climate change adaptation and mitigation require appropriate knowledge, skills and behavior change that education can provide. Specifically, education can enable individuals and communities to make informed of decisions and take action for climate resilient sustainable development. Two major climate treaties, the UNFCCC and the Kyoto Protocol, have articles calling on governments to support education for climate change. This is complemented by the focus on education and knowledge as a priority for risk reduction within the Hyogo Framework for Action: Building the Resilience of Communities and Nations to Disasters, 2005-2015 (Allison, 2010).

Empowering young people in the field of water and sanitation is also a way of assuring that a project or programme has a greater effect and more long lasting impact on the communities. When trying to find solutions to water contamination, environment degradation and ways to improve access to water, sanitation and food security of any given community, it is essential that youth become involved, so they themselves can work together in an organised fashion to identify appropriate solutions to the problems, and then take ownership of the measures to apply those solutions. There are many tools that can be applied in order to involve youth in social or environmental action. This can help raise their self-esteem and also encourage other youth to take similar actions. They can also take part to set targets that aimed at approaching problems from the highest level and working down to the details.

There are approximately 70,000 primary schools and 17,000 secondary schools in Bangladesh. More than 20 million students are enrolled in the primary school. According to an UNICEF assessment, in primary schools about 53% have functional safe water tube well and the rest do not have any option or have non-functional options. Moreover, there are alarming questions about the quality of drinking water and hygienic practices existing in many schools of Bangladesh (arsenic, salinity, bacteriological and other contamination) [Hoque et al., 2011].

Youth are very innovative, creative and they can take part in development activities. They need opportunities to develop skills, and when adequately directed can easily and effectively support organizational work without a lot of experience. Environmental programs should try to involve young people as promoters basically because they have a lot of extra time and energy. In this modern era, young people have access to internet to have tremendous amounts of information and can develop social networking easily. Youth can be involved in awareness raising and capacity building programs regarding water, sanitation and hygiene practices through education.

Over the years Bangladesh Water Partnership (BWP) has been promoting & empowering youth through awareness raising programs as well as capacity building programs on Integrated Water Resources Management (IWRM) and Climate Change Adaptation. BWP also works with 'youth brigades' in primary and secondary schools in rural communities to conduct education and awareness activities on water, sanitation, and hygiene (WASH), water, and climate change.

During the COP21, held in Paris from 30 November to 11 December 2015, 3rd December was celebrated as "Young and Future Generations Day" to engage youth with decision makers, stakeholders and others active in combating climate change. Now it's the prime time for youth to take ownership of their future by playing a central role in implementing sustainable solutions to climate change and water resources management.

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