National Consultation Workshop on

Integrated Flood Management with Focus on Coastal Zones of Bangladesh: Development of a Pilot Project on Coastal Flood Management in Selected Areas of Bangladesh

24 and 25 October, 2014

BRAC Centre Inn, 75 Mohakhali, Dhaka-1212, Bangladesh

Jointly Organized by

PREFACE

Life, culture and economy of Bangladesh have been shaped by the diversified and overwhelming characteristics of its water resources. Flood, drought, storm, cyclone, tides, erosion and sedimentation etc. are common features of in Bangladesh. Over the last several decades various water development plans and projects have been implemented in Bangladesh to manage its water resources for greater well-being of people and the ecosystem. With the passage of time new dimensions of water related problems have also emerged while at the same time new technological development has evolved, better water management understanding and insight of the problem has been gathered. Overall, water management in Bangladesh, particularly flood management is progressing in a desirable manner; still there is a long way to go.

The coastal zone of Bangladesh deserves special attention. It occupies one-third of the country and houses one-fourth of the population. Low lying flat topography and sea-facing location of the region makes it more vulnerable to water related disasters. Coupled with it is decreased fresh water inflow into the region and anticipated climate change induced sea level rise, may make water and flood management in the coastal region more difficult. Bangladesh has made commendable progress in non-structural flood management activities, particularly with respect to flood forecasting and warning, but no such mechanism is yet available for the coastal zone. It is felt necessary that such a system should be in place to manage the coastal flood in a better way, particularly if we are to manage the anticipated sea level rise and allied effects.

The present workshop brings together knowledge and experiences available in the academia, implementing agencies, individual experts and professionals, NGOs and a host of other bodies working in water management in Bangladesh. We hope that a proper blending of the knowledge and experiences gained and exchanged through this will help to formulate ways and means to manage the coastal flood and related hazards in a better way.

M. Shahidul Hassan
President
Bangladesh Water Partnership

Prof. Dr. M Monowar Hossain
Executive Director, IWM, Dhaka
Bangladesh

Table of Contents

Annexes

Annex-1: Workshop Program

Annex-2: Participants' List

Annex-3: Media Coverage

Annex-4: Glimpses of the Workshop

1 INTRODUCTION

A two days long National Consultation workshop on 'Integrated Flood Management with Focus on Coastal Zones of Bangladesh: Development of a Pilot Project on Coastal Flood Management in Selected Areas of Bangladesh' was held in BRAC Centre Inn, Dhaka, Bangladesh, on 24th and 25th October 2014. The workshop was jointly organized by Bangladesh Water Partnership and Institute of Water Modellingin association with World Meteorological Organization, Global Water Partnership and Associated Program on Flood Management. The workshop was attended by Barrister Anisul Islam Mahmud, MP, Honorable Minister, Ministry of Water Resources, Government of Bangladesh;Mr. Iswar Raj Onta,Chair, GWP SAS and Dr. Paul Pilon, Chief, Hydrological Forecasting and WRD of WMO.

Mr. Mohammad Nazrul Islam, BirProtik, MP;Dr. Zafar Ahmed Khan, Secretary, Ministry of Water Resources and Mr. M. Shahidur Rahman, DG, BWDB were also planned to attend the inaugural session, but due to some unavoidable reasons they could not attend. However, Mr. A L M Abdur Rahman, ndc, Additional Secretary, MoWR attended as special guest.

About 75 water professionals working in different government organizations, academic institutions, research organizations, NGOs and Water management Organizations participated in the workshop. A field visit to two coastal polders was followed after the workshop.

Program of the workshop is enclosed in Annex-1 and a list of the participants is enclosed in Annex-2.

2 BACKGROUND AND OBJECTIVES OF THE WORKSHOP

Bangladesh is a deltaic country formed by the three major river system of the world, the Ganges, the Brahmapurta and the Meghna. About one third of the country lies in the coastal region which supports nearly 50 million people. Life and livelihood security of the coastal people revolves around sustainable management of land and water resources of the region. Due to its geophysical location, the coastal population is exposed to miseries of water induces disasters such as cyclones, tidal surges, erosion and sedimentation, salinity intrusion, and in recent time the bite of climate change related hazards. Both population growth and development activities are putting considerable pressure on the natural resource base of the coastal region.

Since late sixties of the last century, a number of flood control projects have been implemented in the coastal region of Bangladesh, with the main objectives of agricultural development. Initially the projects yielded intended benefits, but over time new problems crop up which is ascribed to fragmented approach of water and flood management in the coastal region.

Integrated Flood management comprises a holistic approach for the management of land and water resources in a river basin with a view to maximizing the efficient use of floodplains and minimizing the loss of life and property from damaging effects of floods.

With this perspective, the broad objectives of the consultation workshop are;

- To share lessons, knowledge and experiences for understanding the complex nature of flooding patterns in the coastal zone of Bangladesh.
- To develop a "Pilot Research Project in the Coastal Area of Bangladesh based on the principles of Integrated Flood Management".

The specific objectives of the workshop are;

- To share lessons on current issues and opportunities in addressing flood management methods and practices in Bangladesh and in the region.
- To promote regional Co-operation among the countries of South Asia focusing Ganges, Brahmaputra and Meghna Basins for improved and integrated flood and water management.
- To share water and climate related lessons and experiences.
- To come up with a proposal and devising pilot project in the coastal area of Bangladesh and conduct action oriented field level research.

3 WORKSHOP PROGRAM

The workshop was held during24th and 25th October 2014. On Day-1, the program was divided into two sessions. Session-1 was dedicated to inauguration of the workshop followed by two technical sessions. In the first technical session two keynote papers were presented while in the 2nd technical session several papers were presented with the theme: *Status of Coastal Flood Management, Risk and Hazards in Bangladesh.*

In the second day, three technical sessions were held. In two technical sessions different papers were presented covering theme *'Monitoring, Management and Case Studies-National and International Perspectives'* and *'Gaps in Current Flood Management in Bangladesh and Potential Measures to Address the Gaps'*. In the last Technical session discussion was held on *'Preparation of the Pilot Projects and preparation for the field visit.*

Detail of the workshop program is given in Annex-1.

4 INAUGURAL SESSION

The inaugural session was graced by the kind presence of Barrister Anisul Islam Mahmud, Honorable Minister, Ministry of Water Resources, Government of the People's Republic of Bangladesh. Other dignitaries present in the inaugural session included Mr. A. L. M. Abdur Rahman,ndc, Additional Secretary, Ministry of Water Resources, Government of the People's Republic of Bangladesh; and Dr. Paul Pilon, Chief, Hydrological Forecasting and WRD, WMO.

Mr. Mohammad Nazrul Islam, BirProtik, M.P. and Hon'ble State Minister, Ministry of Water Resources; Dr. Zafar Ahmed Khan, Secretary, Ministry of Water Resources; Mr. M Shahisur Rahman, DG, BWDB and Mr. Bruce Stewart, Director, Climate & Water of WMO could not attend the workshop due to some unavoidable reasons.

Mr. Shahidul Hassan, President, Bangladesh Water Partnership presided over the event.

All respected guests present in the inauguration session highlighted the importance of the workshop and emphasized that this workshop is a demand of time. The coastal region of Bangladesh is vulnerable to different types of natural calamities. Coupled with it, growing population and economic development activities exacerbate the situation. Cyclone, tide, storm surges, river erosion and sedimentation, salinity intrusion, drainage congestion etc. are parts of life of the coastal people. For several reasons the coastal region is different from rest of the country and demands special attention to deal with the challenging water management issues. They hoped that this workshop would help find ways to meet

challenges of water and flood management issues and lead to sustainable socio-economic development of the area.

Verbatim texts of the speeches of the respected guests are presented below.

4.1 Speech bythe Chief Guest, Barrister Anisul Islam Mahmud, Honourable Minister for Water Resources, Government of Bangladesh.

Bismillah-hir Rahman nir-Rahim

Honourable Chairperson, Mr. Shahidul Hassan, President, Bangladesh Water Partnership, Special Guest, Mr. Abdur Rahman ndc, Additional Secretary, MoWR, Government of Bangladesh; Mr. BalkrishnaPrasai, Ex-secretary Government of Nepal; Mr. Paul Pilon, Chief, Hydrological Forecasting and WRD, World Meteorological Organization; Prof. Dr. M. Monowar Hossain, Executive Director, Institute of Water Modelling and Dr. AzharulHaque, Vice President, BWP.

Ladies and gentleman

I am really grateful that I have been invited by IWM at this workshop on Integrated Flood Management which focuses on coastal zone of Bangladesh and development of pilot project in selected areas of the coastal region. I feel that this is a subject which is of very importance and right at this moment, especially in the context of the climate change. This is as because Climate Change is going to affect Bangladesh very adversely.

Chief Guest, Barrister Anisul Islam Mahmud delivering his speech in the inaugural session

Few days ago I was in a seminar and the seminar was regarding flood management and from the perspective of environmentalist. The paper presented was quite philosophical in nature in the sense that it talked mostly about what is water and what is nature? What is environment & so on? The sum total was, most of the works under the MoWRdone through Bangladesh Water Development Boardare not the thing they would want i.e. embankments, sluice gates, bank protections etc.

When I started speaking I talked of the dilemma. In one hand are the environmentalists, who like perfect nature and on the other hand is the demand of the people. In my room at the ministry, honestly to tell you, I spend roughly one hour to do my job. You may ask what I do for the rest of the time. And in fact, I am so busy with the rest of my time that I can't even receive a telephone call.

The reason is that most of the Members of Parliament or the Stakeholders are in my room, giving me papers, asking me to do things exactly opposite to that what has been discussed in that seminars. They want banks to be protected, they want embankments, they wantexcavation of rivers, and some wants sluice gate for drainage. So, these are the things, which I am getting every day. I am telling you if you are interested you may come to my room to see and I am not surprised because, we have three mighty river systemsin Bangladesh - the Brahmaputra, the Ganges and the Meghna. We have hundreds of rivers. Most of our civilization has grown up along the river banks. On one hand, river has

instability, erosion of the rivers is not a new thing, and it is happening for the centuries. Flooding, it has been happening for the centuries.

Now when we talk about integrated flood management, it is a very difficult subject in a way. As I would understand IFM, in one hand flood is controlled, on the other hand the process with soil is revitalized should also continue. Which means certain amount of flood must take place. Today, Bangladesh, being such a small country produces 30 million tons of food grains. This is not because of only the technologies but land is also fertile. If these technologies are applied to other countries, no food production would occur. The reason is that the soil condition and the climates are not the same. So this achievement of food grain production is not only for technology, it is also for our fertile soil which we have to protect. In flood control, this is one thing we have to take care it. Many things have changed over the last 30 years. I was water resources minister 30 years back. To my knowledge, 30 years back we used to talk about to live with flood. At that time we used to design our embankments with certain return period meaning that people were ready to accept a flood after certain time interval and they were used to that. But today's condition is very different from that of 30 years back. Today nobody is willing to live with flood, so this is the situation right now and things has changed.

This year in northern Bangladesh, there was a hue and cry that there is flood in the northern districts. Actually within the embankment there was no flood. Flood was there outside of the embankment, and this is what we wanted to do, i.e. within embankment there will be no flood, but outside it will be flooded. But the outside people also demanded that they also want flood free life. So things have changed, people's perceptions have changed. We need to talk with the stakeholders, and make them understand what we are planning and what we are doing. The problem is that we are planning and executing but we are not communicating. We have to communicate with the people and make them understand. This is because, by now people are also getting newer ideas. Their expectations are also rising and they are not prepared for living with flood. It is not possible to do it tomorrow, but over a period of time. Our house planning should also have to be integrated to the flood. So this is an important part which I have talking about.

The moment we have polders, we have dual problems, flood control and drainage. Most of the polders are 40 and 50 years old. They were constructed in late 60s to protect coastal areas from tidal flooding and salt water intrusion, mainly to promote agricultural production. Polders have numerous sluice gates. Over time, due to several reasons, such as reduction of fresh water flow from upland and changes in the tidal regime, siltation have occurred in the rivers, river beds have been raised and land inside the polders have been lowered. This situation has created drainage congestion in the polder areas. So, while we have solved one problem, i.e. problem of saline water intrusion, simultaneously we have created another problem, drainage congestion. This is the nature of the rivers in the tidal zone that siltation would take place. We have to keep in mind that we do not create one new problem while solving an existing one.

Most of our polders today are facing the same problems. And we are trying to address the problems tidal river management, an innovative water management approach. Evaluation reveals that its performance is quite satisfactory, but has some practical limitation. TRM process requires a substantial amount of land area and this is our major problem. Almost one third money is required for the land acquisition. I would like to thank you all for the idea of pilot project to devise sustainable and low-cost solution for managing the flood problem of the coastal region. I hope that this workshop would be successful in this endeavor. And of course we must integrate local people with technological solutions.

Another thing I must say about is the salinity and the climate change problem. Embankment height should not be based on the past only but also should take into consideration the future. If water flow from the upland northern side reduces there will be greater salinity intrusions. We need Ganges Barrage, firstly for irrigation purpose, which will cover one third area of Bangladesh. It will increase our food production. Secondly it will augment fresh water flow into the coastal region during dry season. We have seen it from the Gorai dredging project, salinity level comes down substantially. I believe Ganges Barrage will reduce the salinity intrusion in the coastal areas. It will protect our environment, agriculture and livelihood.

So once again I thank you all,especially the organizer for inviting me and giving the opportunity to express some of my thoughts.

Thank you.

4.2 Welcome Address by Dr. K. AzharulHaq, Vice President, BWP

Good Morning to you all; today's Chairperson Mr. Shahidul Hasan, President Bangladesh Water Partnership [BWP], the Honorable Chief Guest, Minister for Water Resources [MoWR] Barrister Anisul Islam Mahmud, Government of Bangladesh, Special Guest, Mr. A L M Abdur Rahman ndc, Additional Secretary, MoWR, Special Guest, Mr. Bal Krishna Prasai, Secretary, Government of Nepal & Executive Member, Nepal Water Partnership; Mr. Paul Pilon, Chief, Hydrological Forecasting and WRD, World Meteorological Organization; Prof Dr. M. Monowar Hossain, Executive Director, Institute of Water Modelling; ladies and gentlemen, Assalamualaikum.

Today, in this beautiful sunny morning, I cannot tell you the season, because the seasons have changed, so we cannot differentiate between autumn and spring anymore, however it's a beautiful sunny day. All of you are very welcome because you have taken your weekend off and have been really very gracious sacrificing the weekend in being here with us to discuss a very important issue which is kind a life and death issue for Bangladesh.

Dr. K. AzharulHaq, Vice President, BWP, delivering welcome speech

Floods have been in the area since the country was formed thousands of years ago. Actually this country was formed from the silts that were brought in through floods and by 400 odd rivers and it is estimated that about 1.25 billion tons of silts flows through our rivers and into our lands. Flood has been a part of life; flood has been part of growing up for this country and for the people. Bangladesh, at one time, may be even now, is one of the most flood prone countries of the world and flood damage, in most severe cases, has been estimated to take about 1-1.5% of the GDP in a very bad flood case, like the one we had in 1988 and 1998. Within the country again, the coastal areas are especially vulnerable to the floods and there are also special kinds of floods in the coastal areas.

In the central flood plains, floods that occur are through the overflowing of the rivers and the banks of the rivers, but in the coastal areas the most devastating floods that occur are through the tidal surge. The cyclonic storm that hits the coastal area brings the tidal surge;

some say the highest recorded tidal surge has been about 8 meters. So when they breach, the embankment like they did in Ailya and Sidr about 5/6 years back, they inundated the entire area with saline water, and thereafter the event of Ailya and Sidr in 2008 and 2009, even today those areas have not recovered to their pre-storm condition.

The rivers in the coastal areas have tides, so Tidal River Managementis a big problem. To protect the areas from flood is to protect our population and property in 139 odd polders that have been constructed in the coastal area, but even then there are problems with the flood. Even with all the major dikes built, it seems that every action the government has taken, the nature has a way of bypassing it and doing something more to damage the quality of the life of the people. So today's deliberation is especially directed to the management of floods in the coastal areas, and we have a very long coastal area.

About ¼th or 1/5th of our population lives in the coastal area. It is estimated that if the sea level rises by 1 m by the end of the century which has been predicted by the scientists, a sizable portion of the coastal area will be inundated. So with that scenario, coastal flood management has acquired more importance, and I think this is a very opportune moment to discuss. We have had about 80 years' time to deal with this and see if we can save our coastal areas from inundation, save our coastal areas from flood, save our people who go through such sufferings when coastal areas are hit by flood. So the present government is committed to alleviate the sufferings of the people from all kinds of disaster, including the coastal floods. Coastal floods have special characteristics.

When it submerges the area, which is sometimes up to 10 miles into the inland, it is a huge disaster. So today, we are also going to talk about how to manage the disaster when such kind of flood occurs. So, floods will be defined. We have people from WMO, who have also worked in Vietnam and other countries on such kind of flood managements and especially coastal flood managements. So we have experienced people from there, we have rich experiences ourselves. All these experiences will be combined and we shall form a formidable joint force to face the flood and protect our people, our property and quality of life.

So, with these few words, ladies and gentlemen, I welcome you to this workshop and wish you a very good discussion that will follow the inaugural session. Thank you again.

4.3 Overview of the Workshop by Prof. Dr. M Monowar Hossain, Executive Director, IWM

Respected Chair, Honourable Chief Guest of the inaugural ceremony, Minister, Ministry of Water Resources, Barrister Anisul Islam Mahmud, Special guests, dignitaries, participant, Assalamualaikum and good morning to all.

Prof. Dr. M Monowar Hossain, Executive Director, IWM speaking on overview of the workshop

Let me start by saying today's objectives of the workshops; our main objectives is to share lessons, knowledge and experiences for understanding the complex flooding pattern in the coastal zone of Bangladesh. Another objective is to develop a pilot project in the coastal zone of Bangladesh, based on the principals of the integrated flood management. Already you have heard the problems, which exist in coastal region of Bangladesh over the decades. We have been trying to device solutions and though the solutions are not becoming very long lasting, but it is giving results. We are successfully facing the complex nature of floods which are also developing in various ways. Our additional objectives are to share lessons on current issues and opportunities in addressing the flood management methods & practices in Bangladesh and in the region.

We have some experts from outsides Bangladesh who will tell & share experience on their learning's and share it with us to promote regional cooperation among countries of South Asia focusing Ganges-Brahmaputra -Meghan Basin for improved and integrated water and flood management. Our coastal region covers about 47000 sq. km. land where about 39 million people lives. Population density is 817 person/ sq km. We have 139 polders comprising of 5107 km embankments which provide protection to 12000 sq km. area from flood and salinity intrusion.It is anticipated that population will be about 60 millions by 2050 in this area. So we have to prepare to save and protect this large population.

Here is a digital elevation map of the coastal region which shows that 62 % area is less than 3m above mean sea level. About 86 % is less than 5m above mean sea level, in this region and there are complex river network which are influenced by tidal inundation twice daily. So when fresh water flows from the upstream reduces specially for 6 or 7 month of a year, the tides bring in a lot of sediments into the river system. However there are no enough ebb tides to flush out those sediments into the Bay of Bengal area, so in essence it creates problems. Now in this map of the coastal polders, you can see the polders and these polders have served their purposes over many years. However we need we need to do some repair and maintenance works to revitalize the polders into their operational conditions again and for that reason we need to work with our dedication, honesty sincerity and hard works.

We have many coastal hazards, some of them already said, we have cyclone and storm surges, coastal flooding. This is today's focus discussion. I can see some of these photographs, how it is affecting our coastal people, water and water everywhere and some broken houses. We have waterlogging problems, the reason already mentioned. Water logging starts from the balance of tidal and fresh water flow. This is the example of Kobodakh area, Keshobpur-Jessore area and Satkhira areas. We have coastal erosion, in whole our country; erosion is a big problem. We all know that, but how to combat it ? What

is the best option sustainable and economical? Economy comes first, when we design projects. It requires of correct implementation and design. Partial implementation is a disaster. We all know that very well. So these are some of the erosion problems. This is the picture of Cox's Bazaar and Ramgoti.

We have river sedimentation, so it also creates a lot of problems. When rivers are sedimented, these are drainage channels. It cannot carry any water. So what happens to the surrounding land and the peoples, paddy fields and populations? They are under severe disasters. We have salinity intrusions. This is a big problem we are trying to find solutions to combat salinity, to how it can be curbed since when groundwater saline it will be a problem. So we have to find a way out. Like some diseases which cannot be recovered, we have to die with that. But we have to find a way out.

We have to go for it. We have climate change and sea level. Sea Level Rise [SLR] moves landwards. This is the conceptual positions of sea level of 2030. So we have to keep it also in mind that for design we have to consider it. For various types of coastal hazards we must very aware of their nature. Isohaline line will move inwards. Base condition is 2000 and 60 cm salinity will take some area under salinity influence. You see how much it moves inward from 55 kms and 95 kms.

Very fertile lands will reduced in production under this salinity influence. Not only agricultural production but also other productions. It will help some fish species to grow more but food should be our focus. Because population is increasing. It will 1.75 times you know. Health living and education everything depends on it. These are some of the projections how this area will be flooded. It will keep on increasing as we move on. Projected scenarios of flooding is analogous. So planning and designing of these projects should also be implemented. Now without the climate change, it does not happen but when it happens it will creates stress. It is different from normal inundation. We have to take considerations about these projects. Under these background we organised this workshop.

Thank you very much for your kind and passion hearings.

4.4 Role of WMO and Relevance of the Workshop by Dr. Paul Pilon, Chief, Hydrological Forecasting and WRD, WMO

Honorable Minister Barrister Anisul Islam Mahmud, Ministry of Water Resources; Mr. Abdur Rahman ndc, Additional Secretary, MoWR, Mr. Bal Krishna Prasai, EC Member Nepal Water Partnership; Mr. Shahidul Hasan, President, Bangladesh Water Partnership; Prof Dr M. Monawar Hossain, Executive Director, Institute of Water Modelling; and Dr. AzharulHaque, Vice President BWP, distinguished guests and participants. First of all I shall apologize for my poor pronunciation of your names before I give my little talk.

First of all, please allow me to express on behalf of the secretary general of the World Meteorological Organization, Mr. Michel Jarraud,gratitude and congratulations for conducting such an important workshop which is of course a topic of extreme interest to the people and Government of Bangladesh and coastal areas throughout the world. On behalf of the WMO secretary I would like to welcome you to this workshop whose primary objective is to explore building capacities on integrated flood management. There will be ample opportunities later in the program to further explore the concepts of IFM and how to do so in depth.

Dr. Paul Pilon, Chief, Hydrological Forecasting and WRD, WMO addressing the inaugural session

I would first like to say a few words regarding the origin and role of WMO as I have been requested to do so. I shall then make some comments on the relevance of this workshop and IFM. WMO, for those of you who may not be aware, is a specialized agency of the UN, specializing in meteorology, both weather and climate, operational hydrology and related geophysical sciences. The organization was founded on the 23rd of March in 1950 and currently comprises 185 member states in 6 territories throughout the world. WMO is UN's system's authoritative voice on the state and behavior of the earth's atmosphere; it's interaction with the oceans, the climate it produces and resulting distribution of the water resources. More specifically, the purpose of WMO is to promote and foster meteorology, climatology, and hydrology and facilitate worldwide co-operation for the benefit of the human kind.

Specific activities relate to the development, maintenance and standardization of meteorological, climatological and hydrological observing networks, systems for processing and rapid exchange of data, development and operational hydrology, disaster prevention and mitigation, and research, training and capacity development. As you may know, the WMO works closely with national meteorological and hydrological services of its members which include, ofcourse, Bangladesh. Since its establishment, WMO has played a unique and powerful role in contributing to the safety and welfare of the humanity. Under WMO leadership and within the framework of WMO programs, national meteorological and hydrological services throughout the world contributes substantially to the protection of lives and properties against the natural disasters, to safeguarding the environment and to enhancing the economic and social wellbeing of all sectors of societies in areas such as food security, water resources and transport.

In the specific case of weather, climate and water related hazards, which account for nearly 90% of all natural disasters; WMO's programs provide information vital for the provisions of

advanced warnings that save lives, reduces damages to properties and the environment. Studies have shown that apart from the incalculable benefit to human wellbeing, every dollar invested in meteorology and hydrology services produce an economic return many times greater, often ten times or more than the investment made. A particular importance to this work shop is that the joint initiative of the WMO and GWP namely the Associated Program on Flood Management or sometimes referred to as APFM.

This program facilitates dialogue in integrated flood management and provides platforms for guidance on flood management policies, strategies, institutional development, tools and their implementation. The programs objective is to promote concept of integrated flood management as a new approach in dealing and living with floods. Over the past several years, flood management efforts have often focused primarily on ed-hoc solutions which tended to be rather reactive than proactive. There is a need to develop new approaches to flood management in an integrated, more holistic basin wide manner. IFM is an approach to flood management that improves the functioning of the river basin as a whole, recognizes that floods have both positive and negative impacts and can never be fully controlled. Such an approach seeks to maximize the net benefits from the use of flood plains and to minimize loss of life and property when doing so.

IFM is a process that promotes an integrated rather than a fragmented approach to flood management. It integrates land and water resources development in river basin within the context of integrated water resources management, with a view to maximizing the efficient and beneficial use of flood plains and to minimize loss of life and property.

Although many countries may have already developed and adopted a catchment based IWRM approach there may be a need to further considering incorporating IFM principles and strategies into their efforts. Sustainable and effective management of water resources demands a holistic approach linking social and economic development with the protection of natural eco systems and providing appropriate management linkages in land and water uses.

I wish you all a fruitful workshop and to enjoy the sessions and presentations, but also I would like to encourage you all to take an active participation in the discussions, using this opportunity to benefit from this exchange of experiences and possible best practices. With the combined efforts, we hope to build a better future. Thank you.

4.5 Speech by Mr.Bal Krishna Prasai, Executive Committee Member, Nepal Water Partnership

Respected Chair, Honorable Chief Guest, distinguished dignitaries, ladies and gentlemen. First of all, I would like to thank the organizer for inviting Nepal to attend this two day national workshop on coastal flood management. I wish grand success to this workshop.

As you know, Nepal is a mountainous country and we don't have any coastal flooding in Nepal. Nepal has over 6000 rivers and there are about 5 big rivers. They were derived from the Himalayas and they flow to plain areas and then they enter Bangladesh.

Mr. Bal Krishna Prasai, EC Member, NWP, addressing in the inaugural session

Nepal is among 20 most vulnerable countries in the world and in terms of climate change it is the fourth most vulnerable country and in terms of water related disasters it is the 30th most vulnerable country in the world. Every year during the monsoon period we face floods, flash floods and glacial lake outburst floods in Nepal. Even this year we faced a very heavy flood in the western part of Nepal. Over 500 hundred people were killed and about 90,000 were affected by flood.

In Nepal, we have been making various efforts to manage flood, we are also adapting basin approach and there is a dedicated department to manage floods in Nepal. We call it Center for Disaster Management and it's prevention. For the last few years we have been launching peoples river training programs and its impact have been praiseworthy.

In managing floods, Nepal and Bangladesh, I think we can work together. We can provide information when we have floods in Nepal, as it will ultimately have impact on Bangladesh also. I think we can learn from each other's lesson also. We can share our experience and we can be benefitted mutually. So I think we would be very much benefitted with this workshop and I think I shall learn a lot from this workshop and it'll help to mitigate flood impacts on Nepal also.

Once again, I like to thank you all for inviting us. We wish a grand success of this workshop.

4.6 Speech by Mr. ALM Abdur Rahman, Additional Secretary, Ministry of Water Resources, Government of Bangladesh

Mr. A. L. M.Abdur Rahman, Additional Secretary, MoWR, addressing in the workshop

Respected Chairperson, MrShahidul Hasan, Chief Guest Barrister Anisul Islam Mahmud, MP, honorable minister, MOWR, GoB, Mr. Bal Krishna Prasai, Special Guest and former Secretary of GoN, Other Special Guests and Professor Dr. M. Monowar Hossain, Executive Director, IWM, distinguished guest, participants and ladies and gentlemen, AssalamauAlaikum and a very good morning. I feel it is a real opportunity for me, as well as an honor and privilege to be here among a group of brilliant water scientists and experts from home and abroad. I believe, this workshop will help me to have some idea about water resources management, especially on the management of the coastal zones of Bangladesh from where I hail. Ladies and Gentlemen, we all know Bangladesh is one of the largest deltas in the world with 144,570 sq.km. land-mass and a population of about 160 million. We have 310 rivers of which 57 rivers are trans-boundary. We are fighting to reduce population growth and curbing poverty. In fact, we have had significant progress in the education sector and macro-economic stability as well. It is mentionable that the people of our coastal zones are very vulnerable to water induced disasters. Flood damages their life and livelihood. So, integrated flood management is very crucial for them. The government is giving much emphasis on it. Its flat deltaic topography with very low elevation makes it more vulnerable to natural disasters. With our limited resources and infinite problems, we are trying our label best to relieve suffering of the coastal people. Mr. Chairperson, in Bangladesh, climate related disasters result in economic losses reducing economic growth and slowing progress in curbing poverty. The 1998 flood inundated over two-thirds of Bangladesh and resulted in damages and losses over two billion US dollars. SIDOR cyclone resulted in damages and losses over $1.7 billion. I believe that no problem is unbeatable if we can work together through sharing of knowledge, experience and expertise. I am very hopeful and optimistic that the discussions that would follow the inaugural session will definitely serve our purpose of giving guidelines to devise sustainable solutions in mitigating the problems we are facing now. I offer my sincere thanks and appreciation to the organizers for their pain staking initiatives to have a fruitful workshop. With these few words I conclude. Thank you all.

4.7 Speech by Mr.Shahidul Hassan, President, BWP

BismillahheerRahmaneer Rahim. Honorable Chief Guest, Barrister Anisul Islam Mahmud, Minister in charge of Ministry of Water Resources, Government of Bangladesh, respected Special Guests Mr. A L M Abdur Rahman ndc, Additional Secretary, MoWR, GoB; Mr. Bal Krishna Prasai, former Secretary, Government of Nepal & now EC Member of Nepal Water Partnership; Dr. KhandakarAzharulHaque, Vice President, BWP; Professor Monowar Hossain, Executive Director, Institute of Water Modelling; Dr. Paul Pilon from World Meteorological Organization; distinguished participants, representatives from electronic and print media, ladies and gentlemen, AssalamuAlaikum and good morning.

Mr. Shahidul Hassan, President, BWP

It is indeed a pleasure for me to preside over this very important national consultation workshop where we are trying to develop a model on integrated flood management, especially in the coastal area of Bangladesh. Bangladesh is a flood prone country. We live with flood and we are used to managing floods but we are observing that pattern of flooding is changing day by day. With climate change the pattern is also changing in different ways and we have to find out its management practices to combat it. Also the pattern of flooding in coastal area in particular is also different in nature which we, most of us who are present here, as men of the subject, know very well. We need not to explain it again and again.

We had the welcome address from Dr. AzharulHaqueand the key note speech from Dr. Monowar Hossain. They allowed us to know actually what we are targeting in this two- day-workshop and also from the field visits. Out of 64 districts in our country, beginning from Satkhira to Cox's Bazar there are 15 districts which are includes almost 20% of the whole country alongside the coast. Coastal flooding pattern comes in different ways, as you already heard, in form of tidal-surge, cyclone, regular high tidal waves etc. Those who live there need different type of attention.

Although our track record is very good, whether it is a cyclone or tidal flood, managing it is very difficult. The present Ambassador of USA came to this country in 1998 when the country was under riverine floods and he was telling one day when we were meeting in Faridpur for 3 days during last Ramadan. He said that when he first came to Bangladesh he thought that a huge number of people will die and it will be a huge disaster but ultimately later he could not find anything of that kind. He was surprised and he thought the people have something that they did not know and gradually he came to know that we are very hard working people with high resilience. Also during his second visit he promised our late President Zillur Rahmanthat he will visit all the 64 districts before he leaves the country. It was then that I found him in my hometown Faridpur and he stayed there for 3 days.

I therefore, as President, BWP and the Chairperson who is presiding over the meeting, do not want to take so much of your time because you have already heard the valuable speech from our Honorable Minister of MoWR who is a very knowledgeable person and who has also been a Minister of water resources about 20 years back. He is here and under his able leadership in the water resources ministry I think the activities will be accelerated. What we are supposed to do is to come up with a very good recommendation which would be very useful, practical and adaptable so that in the process of preparing for the future projects in managing flooding in the coastal region, these recommendations can be adopted.

With these few words, I would like to express my sincere thanks to the Honorable Chief Guest, the respected Special Guests and distinguished participants for being here and also listening to me. I conclude here. Thank you very much.

4.8 Vote of Thanks by Mr. Abu Saleh Khan, DED (Opn), IWM

Vote of thanks by Mr. Abu Saleh Khan, DED (Opn), IWM

The vote of thanks was delivered by Mr. Abu Saleh Khan, DED (Opn), IWM. Reiterating the objectives of this workshop, in his speech he expressed his aspiration that the deliberations and interactions during the next two days between the participants will provide us with road map for better water, flood and sediment management in the coastal region of Bangladesh. It is also expected that a pilot project on coastal flood management in selected areas would also be formulated at the end of the workshop the outcome of which will help us to overcome impending challenges in future. He said that the combined knowledge and efforts will contribute in guiding us in our endeavor for better management of sediment and flood in the coastal region in future.

He expressed his gratitude to WMO, GWP south Asia Region for providing financial support to assist in organizing the workshop. He also expressed his gratefulness to the honorable guests, learned participants and audience, and media representatives for sparing their valuable time and taking the trouble in attending the workshop.

5 TECHNICAL SESSIONS

After the inaugural session, several Technical Sessions were held where water experts from both home and abroad presented different case studies and research findings related to flood and drainage management, river erosion and sedimentation, climate changes and other issues that has bearing on coastal flood management. The case studies were preceded by two Key note presentations. Brief of the key notes and the case studies are presented in the following sections.

5.1 Key Note Speech by Dr.AinunNishat, Professor Emeritus, Centre for Climate Change and Environmental Research, BRAC University, Bangladesh

At the beginning of his presentation Mr. AinunNishatsaid that it is necessary to agree on several issues before going into detail of the discussion, they are (i) identification of the area about which we are going to discuss to formulate pilot project i.e. a proper identification and characterization of the coastal zones, (ii) features of flood and inundation and ways and means available to manage them, (iii) integrated flood management vs. integrated water resources management and (iv) possible components of the pilot project.

Dr. AinunNishat presenting his Key Note Speech

Mr. Nishat said that the entire coastal belt in Bangladesh is not homogeneous. Based on geo-morphological characteristics the coastal may broadly divided into four major sub-zones;

- Moribund Ganges delta on the southern part (Shatkhira, Khulna, and Bagerghat) characterized by lack of supply of fresh water and sediment from upstream as connectivity of the tributaries of the Gages is blocked; the rivers are almost non-functional even during monsoon months;
- Semi-active Meghna delta characterized by limited supply of fresh water in lean months and low load of sediment from upstream; but the rivers receive full flow during monsoon months;
- Active Meghna Estuary; supply of fresh water in lean months becomes much low; but the rivers in this zone supply full flow, both water and sediment, during monsoon months;
- Narrow coastal strip of the Chittagong coastal belt

Each of these sub-zones have their own distinctive features that calls for different water management strategy and action plan.

About flood and inundation, Mr. Nishat said that all inundations are not flood, only when damage is associated with inundation i.e. when inundation causes damage to property and

crops, disrupts communication and brings harmful effects to human beings as well as to flora and fauna, we call it flood. The magnitude and nature of damage depends on several factors e.g. location, timing, extent, duration and depth. In normal monsoon, about 25% of the country is inundated and that is beneficial for our eco-system in different ways. Floods in Bangladesh can be of several origins such as, river flood/ flash flood, storm surge, drainage congestion, tidal flood from spring tide etc. In the coastal region flood can occur from a variety of sources such as;

- River Flood
- Drainage congestion as river bed has gone up
- Tidal flood from spring tide in monsoon in areas without polders
- Tidal bore associated with spring tide and cyclonic disturbances
- Storm surge accompanying major cyclones

Depending on the varying characteristics of the causes of flood, each type of flood demand different approachfor its management.Presently Bangladesh uses a blend of both structural and non-structural measures for managing the flood. Although a variety of options are available under each measure, all are not suitable for and practiced in Bangladesh.

Options available under structural measure include;

- Dams and Reservoirs for impounding excess runoff. Detention basin, Retention Pond to lower the level of flooding downstream***(not feasible due to topographical limitation).***
- Embankment, Dyke, Polder, Levee, Bund, or Flood wall to block the movement of water from rivers to floodplain. ***(most preferred option)***
- Improvement of Conveyance Capacity ***(planned but not done due to cost element)***
- Flood bye pass, flood diversion ***(not feasible)***
- Watershed Management, and afforestation ***(not practiced.)***

Similarly, options available under structural measure include;

- Flood forecasting (done) and warning(poor practice)
- Flood fighting (a success around cities)
- Flood proofing (traditional practice)
- Evacuation and shelter management (a success story, standing order of GoB)
- Flood insurance
- Floodplain zoning
- Changes in cropping pattern

Concerning flood management options he opined that structural measures provide protection to the vulnerable area up-to certain level of flooding, and is mostly preferred by engineers and local people. On the other hand non-structural measures attempt to reduce loss or damage due to flood. This option is preferred by social scientists and conservationist. An integration of structural and non-structural measures is essential for effective disaster management, he added.

About Integrated Flood Management versus Integrated Water Resources Management he opined that we should go for IWRM and in this endeavor could be guided by the Eleven Guiding Principles as laid down in Flood Policy, 1989.

About possible components of the pilot study, he suggested to considering the following;

- Infrastructure: decide upon need of infrastructure that will be needed for IWRM/IFM
- Institution: Work out the institutional mechanism for IWRM/IFM Practice
- Operation of infrastructure: who decides on operation of gates

- Investment/ input: who will pay for infrastructure building? May be public sector may take care! But subsequent responsibility for operation and management must be decentralized and cost for operation and maintenance must come from beneficiaries.

Summing up the presentation he said that;

- Flood Management is often crisis driven responses. Floods may not occur regularly; if interval between two events is long, a flood may provoke an immediate crisis.
- Bangladesh needs to move from approach of flood management to integrated water resources management.
- Integration of structural and Non-Structural options is yet to be achieved.
- Un-predictability of weather will be a major factor in IWRM practices
- For the SW region we need to keep in mind that cropping pattern has changed since construction of polders in 1966-1969, water logging is a serious issue for the region, conflict between shrimp and paddy is getting more complex, the area is highly vulnerable to storm surge; sea level rise and reduction of flow from upstream region has increased salinity to such a high level that supply of drinking water is a big challenge.

5.2 Key Note Speech by Dr. Paul Pilon, Chief, Hydrological Forecasting and WRD, World Meteorological Organization

The second key note presentation in the workshop was made by Dr. Paul Pilonfrom World Meteorological Organization.The theme of his key note was 'Lessons of Coastal Zone Flood Management- International Perspectives'. He stressed through pictorial representation on all aspects of floods, advantages it imparts, opportunities that it creates, associated risks, effects on livelihoods and ecology.

Dr. Paul Pilon, Chief, Hydrological Forecasting and WRD, WMO, presenting his Key Note Speech

Hence accordingly there are bright sides of rich silt settling on floodplains like advantages in agriculture, fishery, recharging water source and some dark sides too which impose risks on lives. Statistics shows that number of deaths by natural disaster such as storm and flood in floodplain country like Bangladesh is very high which resulted in huge economic damage. He gave an outline of major recent disasters that took place in the world. In Asia, he emphasized on through statistics that number of flood threatened people is projected to have increased up to 39% between1970 and 2030. He also outlined disaster related economic losses that took place in various location of the world including China, India, Bangladesh, Thailand, and Japan & North Korea. He also gave an indication on projected increase in the number of people exposed to floods in 2030 compared to those of 1970.

Dr. Pilon then gave a brief introduction to Associated Program on Flood Management founded in 2001 as a joint initiative of Global Water Partnership and WMO. It was founded with a mission to support countries within the overall framework of Integrated Water Resources Managementwith contribution from Switzerland, USAID, Germany, Italy & Japan. Main objectives of these flood management initiatives are to maximize net benefits and minimizing loss of life the values being "not to avoid losses at all costs". The objectives were elaborated explicitly on how activities on and use of floodplains from agriculture, urban development, transportation & recreational use can reduce or avoid direct damage in mid & long term perspective in environmental & socioeconomic impacts. Economic, legal and institutional, social and environmental aspects are included in this management. For minimizing loss of life he stressed on end to end flood forecasting mechanism, prevention, preparedness, response, recovery & reconstruction to flood damage.

For coastal flood risk management, a step by step procedure was presented pictorially through a logical structure. Schemes to be adopted includes activities which involves estimation and prediction of flood hazard and its impact, assess coastal vulnerabilities, analysis of policies and selecting measures and integration of policies and measures for mainstreaming coastal flood risk management. Finally a costal information system has to be developed which could maneuver & provide assistance in mitigation the flooding events.

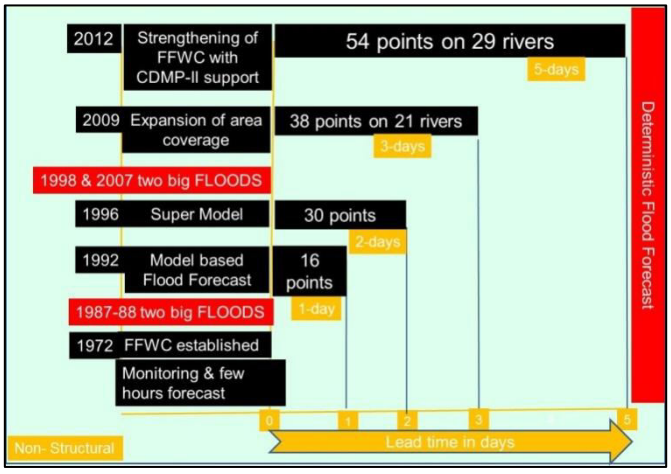
He stressed that it is very important to determine which areas are to be protected, from which areas people are to be moved away and at which areas adaptation is possible. He outlined proper land use management, water resources management & resource management in a coherent manner for IFM. He mentioned of increasing attention towards broader range of measures for an integrated approach, keeping traditional protection measures essential in coastal flood risk management, emphasizing of coastal ecosystem and non-structural measures like land use planning & risk management. In this regard he cited storm protection by mangroves which can be effective for Bangladesh and entire South-East Asia to be an embodiment in this matter.

He also cited Cyclone Hazard Mitigation Project in Andhra Pradesh, India can be presented as a case study regarding Integrated Coastal Zone Management ICZM which included provision of a number of tools and products for implementation of ICZM, GIS based decision support system, capacity building and on the job training. In this regard, he outlined the major components involved in the project: short-term and operational initiatives and long-term strategies along with the outcomes & a conclusion. He elaborated the benefits of the project.

He then outlines his experiences on Polder Management from the Netherlands. From the experience for land reclamation, modern polders are used though traditional polders are used to protect from sea. However, he also reflected on the scope of polder's use which is limited due to limited storage capacity, siltation, overly rapid discharges, insufficient drainage capacity and extra seepage water caused by water logging. In the end as a guideline to his presentation he referred "Coastal and Delta Flood Management", 2013 a publication for further reading materials on APFM Tools.

5.3 Presentation by Mr.Md. Amirul Hossain, Executive Engineer Flood Forecasting and Warning Centre, BWDB, Dhaka

Coastal Flood Management in Bangladesh was the topic of presentation by Mr. Amirul Hossain. In his presentation he told that Bangladesh is located at the tail end of three major river system of the world-the GBM basin. Only about 8% of the basin area lies within Bangladesh and the rest is outside. Due to its geophysical location, Bangladesh is prone to flood and associated disaster. High population density makes the situation more critical. Bangladesh Water development Board, the leading water management organization of the country, is working since 1960 to manage the country's water resources in general. However, flood forecasting, as a means of flood management got due attention in 1972. In normal flood about 25% area of the country is flooded which rises to about 68% in extreme flood- that happened in 1998. A two way approach: structural and non-structural approach is adopted by BWDB in managing the flood. Till now BWDB has constructed about 10,608 km embankment of which 4,671 km is coastal embankment. These embankments are the backbone of the structural flood control measures. On top of this, as a part of non-structural measures, BWDB has a fully functional flood forecasting system that current issues flood forecast at 54 locations in 29 rivers, with 5 days lead time. Although performance of the existing system is quite satisfactory, it does not, however, covers the entire country. At present our coastal region is not covered by the flood forecasting system of BWDB. Considering the vulnerability of the coastal region to natural disaster, time has come to extend the flood forecast coverage in the coastal region. To this end, Mr. Hossain made some recommendation for consideration.



Flood Forecasting & Warning in Bangladesh; Step by Step

Suggestions that relates to structural measures

- Where possible, flood control structures
- Ganges Barrage project
- Capital and pilot dredging of rivers & water ways
- River bank protection/Erosion Control
- Coastal Embankment and Polders Strengthening
- Land Reclamation and Char Development along the coastal zone
- Land reclamation from the major rivers for creating Special Economic Zone

Non-structural measures include:

- Coastal/Tidal Flood forecast Flash Flood forecast
- More area coverage under FFWS
- Medium & long range (seasonal) forecasts
- Flash Flood Forecast or Guidance (South East)
- Erosion prediction
- Salinity intrusion forecast in coastal belt.
- Drought prediction

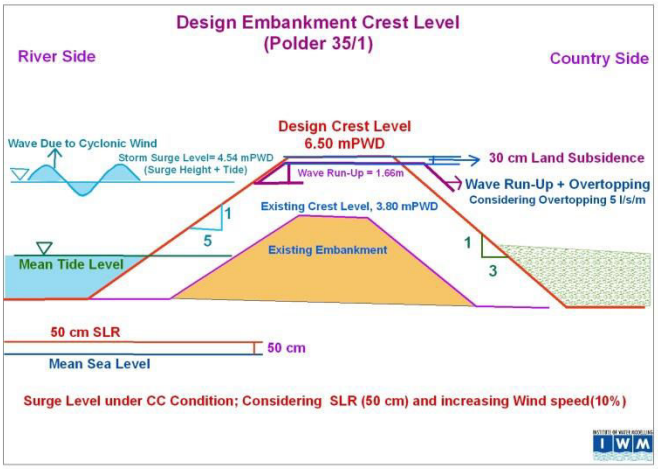
- Use of satellite based technology for increase FFWS
- Enhancement of data collection by telemetry
- Regional cooperation/data, knowledge & skill shearing
- Basin wise Flood Forecast

5.4 Presentation by Mr. Rubayat Alam, Senior Specialist; Coast, Port and Estuary Division, IWM

In his presentation Mr. Alam concentrated mainly on the nature of coastal flooding in Bangladesh, capacity of IWM in numerical modeling of coastal flooding and present practices to cope with coastal flooding with consideration to SLR issues. He said that coastal area comprises about 26% of Bangladesh country and nearly about 38.50 million peoples live there which is expected to rise to about 60.80 million by the year 2050. He informed that coastal flood in Bangladesh can be various character depending on the nature of their origin such as storm surge, Tsunamis, shallow coastal flooding, inland floods etc. On top of these, new challenges have arisen due to global sea level rise and relative sea level rise which can lead to long term coastal inundation.

To manage the classical coastal flooding i.e. flooding originating from tides, cyclone and storm surges, Bangladesh has implemented about 139 polders with 5107 km coastal embankment. These embankments form the backbone of Bangladesh's coastal flood management activities. Height of the existing embankments varies from 3.00 m to 7.00 m which will have to be significantly increased if effects of anticipated SLR and land subsidence are considered.

A recent study for a polder (Polder no-35/1) indicates that embankment crest level has to be redesigned at 6.50 mPWD from the existing 3.80 mPWD to protect the polder area from SLR, land subsidence and cyclonic wave; which is an increase of embankment height by 71%. Such increase in embankment height will require a large capital investment in redesigning the coastal embankments.



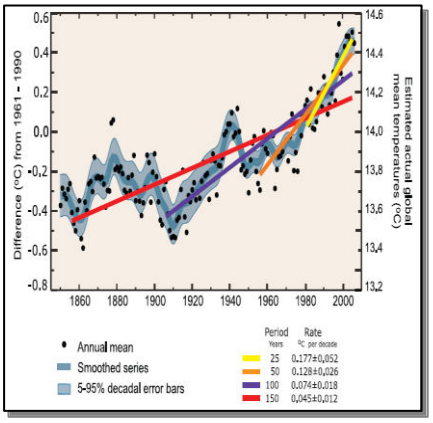
Bangladesh has made considerable advancement in building its capacity in the field of numerical modeling and simulation of tide and wave propagation, cyclone and storm surges and tsunami. A suite of mathematical models now exists at IWM which are widely used for simulation of the coastal phenomenon taking into consideration tides, cyclones, SLR, Tsunami etc. However, they need to be continuously updated and upgraded to make the simulations more efficient and location specific. This modeling capacity would immensely help Bangladesh to protecting its coastal region from the vagaries of water induced coastal hazards.

5.5 Presentation by Mr.Dilder Ahmed, Director, Department of Disaster Management, MoDMR

limate extremities and its impact in Bangladesh: Present status and projection was the topic of his presentation. In his presentation he tried to demonstrate the likely impacts of climate change on different components of the bio-physical environment of Bangladesh followed by an adaptation strategy for consideration.

Bangladesh is a low and flat deltaic country with 80% of the area located in the floodplain of the three major river system of the world. 90% discharge of the GBM basis passes through Bangladesh while only 7.50% area of the basin lies in Bangladesh. Geo-physical location of the country coupled with high population density makes the country more vulnerable to natural disasters. Flood, drought, tornados, storms and cyclones etc. are common in Bangladesh. Since independence in 1971, about 200 disaster events have occurredcausing more than 500,000 deaths and leaving prolonged damage to livelihoods, infrastructure and the economy. It is anticipated that global warming and sea level rise may adversely alter the pattern of climatic disaster in future. Research and studies indicates that over the last 100 years the rise of global temperature was 0.74^0C.

During the last 50 years the decadal rate of rise of temperature was 0.0260C/decade which was became double (0.0520C/decade) during the last 25 years.



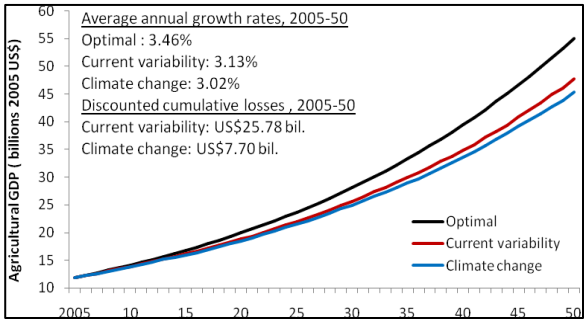
Rate of Temp. Change over the Last 160 Years

It is estimated that by the end of this century, global temperature may increase by 1.80-4.00 degree Celsius and the sea level may rise by 0.18 – 0.59 meters. This increase in climatic parameters would have multifarious effect on the physical system such as drought, heavy rain, heat stress, floods, river bank erosion, cyclones and storm surges, sea level riseand salinity increase; which in turn would have impact on the human system such as water management, agriculture and food production, industrial production, power demand, infrastructure, human habitation, urban issues, health, demography – migration, disaster management, massive displacement etc.

Two things are most likely to happen. Firstly, temperature will rise and events of extreme temperature would be more frequent. Secondly, rainfall will be uneven and uncertain with both increasing heavier rainfall and less rainfall. Both will increase the likelihood of drought in future and drought would have multi-layered impact on others. Notable impacts of drought are;

- Lowers agriculture yield – Aman yield may fall by 35-40% for moderate drought and 45% by severe
- Borocrops may be affected more – for wheat and potato losses may be 50% or more for moderate drought
- Fall in output leads to income and employment losses and consequently consumption losses
- Health problems particularly gastro enteric diseases more frequent
- Scarcity of drinking water, bathing of humans as well as for cattle. Besides, drought will have devastating impact on cereal production, fishery, live stokes, health etc.

The overall impact of climate change would be a reduction of GDP growth rate from the optimal rate of 3.46% to 3.02% as illustrated in the adjoining figure.



Impact of Climate Change on Agricultural GDP

Mr. Ahmed concluded with a set of adaptation strategies and actions that included

- Carry out more research on climate extremes increased - when and in what severity.
- Long-range weather forecasting for early warning on drought, flood and other extreme events.
- Community-based adaptation.
- Strong advocacy and build alliance for integration of DRR, CCA and sustainable development to the post -2015 development agenda and HFA on DRR Framework

5.6 Presentation by Mr.Md. MahfuzurRahman , Project Coordinating Director, CDSP-IV, BWDB

Mr. Rahman spoke on 'Risk and Damage Assessment of Coastal Floods in Bangladesh'. In his presentation he mentioned that there are a variety of risk factors related to flood in the coastal region of Bangladesh. The significant risk factors are Cyclone and storm surge, Sea Level Rise, Saline water intrusion, River bank erosion (Dynamic estuary and estuarine flow in monsoon tide/ebb), Monsoon unusual high tidal flood (inundation & disruption livelihood in coastal islands), Local level risks etc. He informed that with a severe cyclonic storm about 2.09 million ha area is under risk of more than 1 meter inundation which may increase by 14% under climate change condition.

A cyclonic storm in the coastal region affects nearly all sectors of the economy such as housing, transport, electricity, water and sanitation, urban and municipal services, water resource infrastructures, health and nutrition, education, agriculture, industry, commerce, tourism and not to speak the environment. According to an estimate total damage due to cyclone SIDR stood at about US$ 1675 million of which damage to physical assets was about 69% of the total damage. Damage to BWDB infrastructures were about BDT 4,918 million. According to a World Bank study, potential damage from a 10-year return period cyclone in a changing climate could be around US$ 2,436.6 million. As a means of combating this sort of damage, he suggested to;

Infrastructure/ sector asset	Damage estimate (million US$)	Loss estimate (million US$)
Housing	1,947.3	0.8
Education	9.0	835.4
Agriculture	75.4	1,084.0
Non-agricultural productivity	87.9	52.7
Roads	239.5	150.0
Power	60.2	
Coastal protection	17.3	
Total	2,436.6	2,122.9

Potential damage from a 10-year return period cyclone in a changing climate

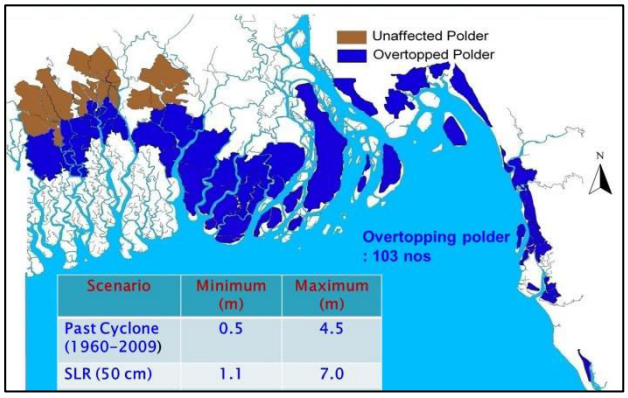
- Forecast cyclone induced storm surge inundation depth & damages to community level for polder and non-polder coastal area/islands;
- Forecast monsoon spring tide inundation to reduce damage & disruption of livelihood opportunities of coastal islands communities;
- Building infrastructures (flood control & others) considering cyclone and surge;

- Integrated development of coastal zone;
- Improvement of existing storm surge/coastal flood model and;
- Development of inundation model for polder / non-polder area considering real-time bathymetry of coast (estuary) & hydro-morphological data.

5.7 Presentation by Mr. Md. Sarafat Hossain Khan, Project Director, CEIP-I, BWDB

Mr. Sarafat Hossain Khan spoke on 'Measures for Reducing Losses due to Coastal Flooding' in Bangladesh. He said that Bangladesh is one of the most water induced disaster prone countries in the world. Many factors contributed to its vulnerability notable are geo-physical setting of the country, low land-topography along the coastal region, high population density etc. Nearly one-tenth of the global total cyclones occur in the Bay of Bengal, and during the last 20 years 60% of the worldwide deaths caused by tropical cyclones occurred in Bangladesh.

He informed, different studies indicate that water related impacts due to climate change and sea level rise are likely to be the most critical issues for Bangladesh. NAPA indicates that the coastal zone vulnerability would be acute due to the combined effects of climate change, sea level rise, land subsidence and changes of upstream river discharge & cyclones. To protect the coastal region from salinity intrusion and tidal inundation, about 139 polders have been constructed in the coastal region over the last few decades. Frequent occurrence of sever cyclonic storms and high tidal amplitude demonstrate that existing coastal embankments and drainage systems are not sufficient enough to protecting the coastal region from the tidal and cyclonic surges. Numerical simulation of the combined effect of storm surge and sea level rise for the climate change scenario of 2050 indicate that about 103 polders are likely to be overtopped causing multidimensional dame to life and livelihood, infrastructures, ecosystem and the overall economy. Furthermore, the depth of inundation would also increase under climate change scenario.The simulation revealed that under climate change condition in the year 2050, considering a 50 cm rise in sea level, minimum and maximum inundation would be 1.10m and 7.00m respectively whereas minimum and maximum inundation during the post-cyclone period (1960-2209) was 0.50m and 4.50m respectively. BWDB has under taken various measures for safeguarding and protecting the coastal region from the anticipated calamities of climate change and SLR. He opined that, for safeguarding the coastal region from the ill effects of climate change and related disasters an action plan is required that may include;



Overtopping of Coastal Polder (Worst Scenario of storm surge)

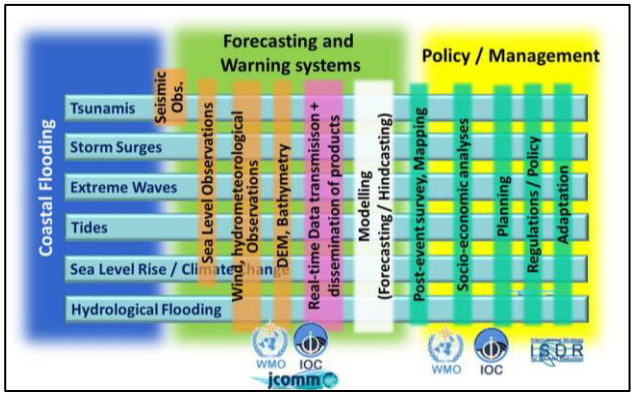
- Systematic Improvement of Coastal Polders considering Climate Change and other Drivers of change.
- Long Term Monitoring, Research and Analysis of Bangladesh Coastal Zone.

- Understanding the tidal and sediment dynamics at present and future through monitoring and applying state of the art Technology.
- Forecasting & Early Warning of Cyclone induced Strom Surge Inundation in the Coastal Zone of Bangladesh

5.8 Presentation by Dr. Paul Pilon, Chief, Hydrological Forecasting and WRD, WMO on Coastal Inundation Forecasting: Demonstration Project

Dr. Pilon spoke on 'coastal inundation forecasting: a demonstration project'. In his presentation he said that Coastal inundations are an increasing threat to the lives and livelihoods of people, living in low-lying, highly-populated coastal areas. According to the World Bank Report 2005, at least 2.6 million people have drowned in coastal inundation, particularly caused by storm surges, over the last 200 years. Coastal areas of the world face a range of risks related to climate change (IPCC 2007).Anticipated risks include an accelerated rise in sea level, an intensification of cyclones,and larger storm surges among others. The risk also increases due high population living in the coastal region.In many parts of the world, the population is directly exposed to the coastal hazards and this will increase with Climate Change and Sea Level Rise. To cope with the situation an 'end to end coastal inundation management' is required which has two main components: forecasting and warning system, and policy/management. Forecasting and warning system requires observation network and observation, transmission, data processing, forecasting and warning generation etc. Policy and management requires post event survey, socio-economic survey, policy and regulation, adaptation etc. A big challenge in this process is Institutional Collaboration forCoastal Inundation Warning/Management.

A demonstration project would be formulated to meet challenges of coastal communities' safety and to support sustainable development through enhancing coastal inundation forecasting and warning systems at the regional scale. Objective of the demonstration project is to building improved operational forecasts and warnings capability for coastal inundation that can be sustained by the responsible national agencies. The project will



End-to-end Coastal Inundation Management

- Identify and support end-user needs;
- Encourage full engagement of the stakeholders and partners in the CIFDP from early stages, for the successful development and implementation of this project;
- Transfer technology to the adopting countries;
- Facilitate the development and implementation of warning services;
- Support coastal risk assessment, vulnerability and risk mapping;
- Assist improved and informed decision-making for coastal inundation management

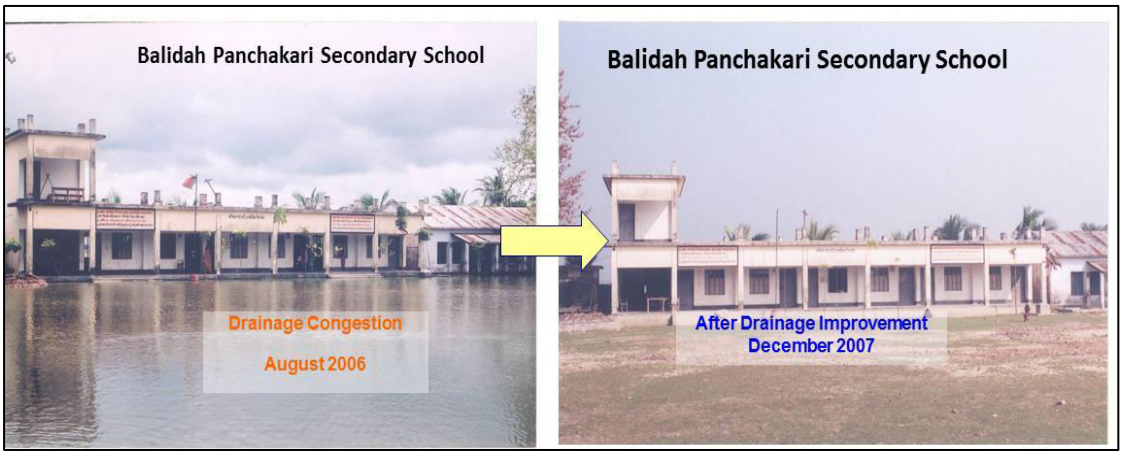
In his presentation Dr. Pilon also highlighted on benefits for implementation countries, Operational Service for Coastal Inundation Forecasting/Warning, national commitment, key players of implementation, applying available techniquesfor integrated operational forecasting/warning, CIFDP within WMO cascading framework, CIF Implementation and

Service offerings, Technical Development for CoastalInundation Forecasting/Warning, CIFDPSystem Design, implementation plan and time line etc.

5.9 Presentation by Mr.Abu Saleh Khan, Deputy Executive Director (Opn.), IWM

Bangladesh is a low laying deltaic country formed by sediments carried by the three major river system of the world: the Ganges, the Brahmaputra and the Meghna. It drains a catchment area of about 1.70 sq.km, 90% of which lies outside Bangladesh. Low laying flat topography and a large and complex river network makes the country vulnerable to flood and related disaster. The coastal region of Bangladesh comprises about 30% of the country where about 25% of the country's population live. From time immemorial, this coastal region is subjected tidal influence, cyclone and cyclonic surge that made the region less favorable for agricultural and economic development compared to other parts of the country. Since 1960s, systematic water management activities were started in the region and till now 139 polders have been constructed in the coastal region. The polders were mainly intended to protecting agricultural land from salinity intrusion. This have resulted a significant rise in agricultural development in the region. On the other hand, over time, these polders coupled with reduction of upland fresh water flow have created severe drainage problems in some parts of the coastal region. Polderization has reduced the tidal prism that subsequently led to sedimentation in the river bed making the river bed elevated compared to the natural ground level inside the adjoining polders. This difference in river bed level and natural ground level i.e. high river bed level and low ground level culminated in severe drainage congestion in the coastal region.

To remove the drainage congestion, a scientific innovative concept, widely known as Tidal River Management (TRM) was tested in several polders such as beelKedaria, beelKhuksia, beelBhiana etc. In this concept, sediment laden tidal water is allowed to enter in a selected polder in a controlled manner where the sediments are deposited. The sediment free clean water drains out during low tide and erodes the river bed and increases its conveyance capacity. Over time, the low laying land levels within the polders are elevated, river beds are lowered, and subsequently drainage congestion is removed. Before implementing TRM in any polder, detail investigation is carried out through application of mathematical models that guides in proper implementation of the TRP based on scientific analysis.



A post review was carried out of the application of TRM concept in several beels and it is observed that the introduction of tidal river management (TRM) appeared to be a technically feasible, environment friendly, socially acceptable and effective solution. Implementation of tidal basin increases tidal prism that results in increasing the drainage

capacity of the rivers at downstream of the basin by natural dredging and allow the sediment to deposit inside the basin.

5.10 Presentation by Dr.HenkWösten, Delta Alliance

The Netherlands is the best protected delta in the world. But how can we ensure that we remain protected from high water – now and in the future – and that our supply of freshwater is secure? In addition, how can we ensure that the Netherlands remains an attractive country in which to live, work and invest? The measures that are necessary to this end are prepared and elaborated in the Delta Programme. The Delta Programme is a national programme in which the Dutch government, provinces, municipalities and water authorities work together in collaboration with civil society organisations, the business community and knowledge institutions under the direction of the government commissioner for the Delta Programme (the Delta Commissioner).

Every year at the state opening of parliament the Delta Programme for the year ahead is presented to the House of Representatives. Reasons for the Delta Programme is that we are safe and that we stay safe. That we are able to live in our delta can never be taken for granted. It demands constant efforts to ensure that we are safe, and stay so. The work is never finished. Measurements show that the sea level is rising and subsidence is occurring. We are expecting more extreme weather with more wet periods. Rainwater must be discharged via the rivers. The prevailing safety standards date from the 1960s and were set after the disastrous flood in the south-western Netherlands in 1953.

Today, we have more to protect than we did 50 years ago. Away from the coast and behind our river dikes lies a densely-populated area with people, animals and goods that are vulnerable if flooding occurs. Almost 60% of our country is vulnerable to flooding, including our economic heart. Flooding results in unimaginable suffering and damage. Protection from floods – caused by the sea as well as by our large rivers – is therefore of vital importance.

Measurements show that the temperature is rising. We expect that our summers will become increasingly warmer and drier, which will put our supply of freshwater under pressure. Not so much our drinking water, but water on which the agriculture sector, industry and nature depend.

The measured rise in the sea level, subsidence and rising temperatures are forcing us to look further ahead and to anticipate developments that will occur in the distant future. Moreover, our current safety measures are not in completely good order. We want to avoid disasters and ensure that we are well prepared for the events of today and those of the future.

Many people and various generations of Dutch men and women will be affected. For this reason, the Delta Programme is a national programme in which the government, provinces, water authorities and municipalities work together. Civil society organisations, the business community and knowledge institutions are also actively involved. The Delta Programme is directed by the Delta Commissioner, the government commissioner specially appointed by the cabinet for this purpose. We are working together on a new-style Delta Plan with Dutch pragmatism, in the present with a view to the future. Our aim is to maintain the Netherlands as a safe and attractive country.

To prepare well for the future we need to take measures for the short term that are in line with the long term. Measures that allow us to expand our capacity to adapt and withstand extreme situations.For example, by giving rivers more room; or by strengthening the coast with sand so that it can cope with the rising sea level.

By adaptive delta management the necessity to take drastic measures can be delayed. We can use the time we gain to learn more about the changes in our climate and to develop innovative solutions. Scenarios can help us to identify turning points in the policy that call for dramatic measures. With this strategy of taking measures now to delay certain turning points, for example by taking future water issues into account when building in particular areas, we are ensuring that the available funds are being spent as efficiently as possible. Currently the draft Delta Decisions are:

Delta Decision on Water Safety

The focus of the draft Delta Decision on Water Safety is on new water-safety standards. These new standards will be drawn up using a risk-based approach in which the risk of flooding and the possible consequences thereof together determine the level of the standard.

Delta Decision on Freshwater Strategy

The freshwater supply is already experiencing problems in dry spells. It's expected that problems will occur more frequently in the future. The government is unable to meet every demand for freshwater in every situation. It is important that water users have insight in what to expect. The draft decision on Freshwater therefore proposes that supply levels be set.

Delta Decision on Spatial Adaptation

The draft decision on Spatial Adaptation contains proposals for the water-robust spatial development of the Netherlands. This includes an assessment framework to properly assess the consequences spatial development investments entail in terms of flood risk.

Delta Decision on the IJsselmeer Region

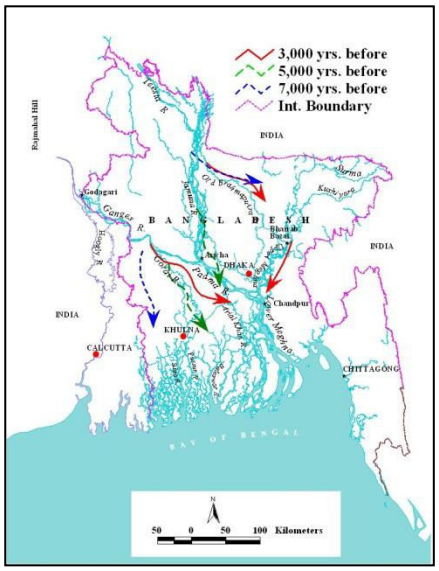
The draft decision on the IJsselmeer Region involves three strategic choices: discharge into the Wadden Sea, the water levels of the IJsselmeer, Markermeer and the Randmeren (border lakes in the Veluwe region), and the freshwater supply. According to the draft decision, the IJsselmeer can remain at its current winter level up until 2050.

Delta Decision on the Rhine-Meuse Delta

The Rhine-Meuse Delta is the transitional area in which the rivers and the sea converge. It comprises the area of the large rivers, Rhine Estuary-Drechtsteden and the South-western Delta. The draft decision on the Rhine-Meuse Delta involves four elements: the application of new flood defences, the distribution of the discharge from the Rhine across the branches of the Rhine (the Waal, Lower Rhine and IJssel), water storage in the Grevelingen, and the freshwater supply.

5.11 Presentation by Dr.MaminulHaqueSarker, Deputy Executive Director, CEGIS

Mr. Sarkar Spoke about century–scale river shifting in the Bengal Delta. In his presentation he said that rivers have three functions, to transport water and sediment, and land formation. As such it is necessary to have a clear understanding of the river building process if we were to manage them properly. Bangladesh is a deltaic country formed by the Ganges, Brahmaputra and Meghna rivers. These rivers entered Bangladesh through three corridors, namely (i) Rajmahal Hill and Barind Tract, (ii) Barind and Madhupur Tracts and (iii) Madhupur and Maghalaya Hills respectively. Every year these rivers carry one trillion m^3 of water and one billion ton of sediment and more sediment make the rivers more dynamic. He said that over the last 7000 years the three major rivers have shifted their course significantly. Even in the recent past there are evidences of their avulsions and the rivers are continuously adjusting with the process of delta building. In this delta building process, over the last 60 years, there occurred a net accretion of about 1700 km^2 and Delta has prograded about 50 km towards the sea. In the presentation Mr. Sarker informed that during the period 1776-1943, rate of net accretion was only 4.5 km^2/yrwhich has increased to 43 km^2/yr during the period 1943-1973. This increase in accretion rate mainly occurred due to the huge sediment generated by 1950 Assam earthquake. In the following four decades the rate of net accretion was reduced to 17 km^2/yr. He concluded that:



Shifting of River Course in Bengal Delta

- The delta is prograding
- In the last centuries, courses of the river shifted from west to east
- Courses of the rivers are changing in southwest direction
- Large sediment input due to the 1950 earthquake have pronounced effects

He further said that delta building processes are the main cause of shifting of the delta building estuary to the west anddistributary rivers to the southwest direction. High sediment input expedites the shifting and avulsion processes. It is likely the river shifting will be more rapid due to anticipated climate change. A proper understanding of the delta building process is necessary to decide on our future course of action that may include;

- Do nothing: rivers will shift as the natural process demands
- Fix the river to avoid the river shifting and subsequent consequences;
- Work with the nature: guide the river for develop and raise the land in the depressed areas to compensate the inundation due to sea level rise

5.12 Presentation by Professor Dr Bilqis Amin Hoque

Recalling the classical definition of Integrated Water Resources Management that calls for maximizing the economic and social welfare without compromising the sustainability of the vital ecosystem, Prof. Haque stressed the need for mainstreaming gender issues in water management. In Bangladesh, domestic water supply, hygiene and sanitation at the house hold level is mostly managed by women, and this is particularly true in the coastal areas. In coastal region, availability of potable water is genuine crisis. Being the water manager at the house hold level, women need to bear the burden disproportionately.

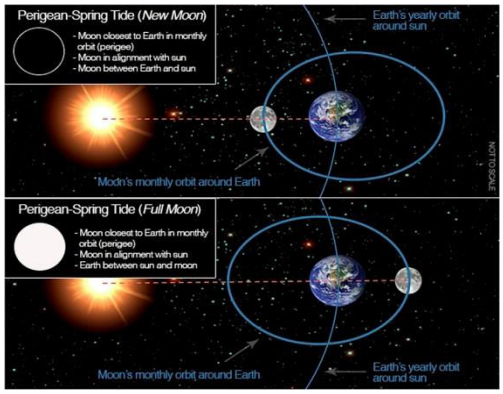
She noted that although women constitute about half of the population but encouraged for one-third representation in WMOs, WMGs and rarely encouraged for decision making positions. Women manage water supply, sanitation and hygiene but rarely lead in community decision making for safe drinking water devices. Maximizing the net benefit from IWRM is challenged by inadequate and questionable interest in annual renewal of EIA, integration of water quality monitoring and its management, integration of WASH, need analyses, technological and institutional development, equitable and effective gender mainstreaming in decision making and implementation, gender sex disaggregated data by activities, policies, laws and acts, proper research based best mix of strategies etc. may be attributed to the present 'women and water' situation in Bangladesh.

5.13 Presentation by Mr. Md. Saiful Hossain, PSO (Eng), WARPO

Proper management of coastal flood has significant bearing on the overall economic development of Bangladesh. The coastal zone occupies about 30% of the country, nearly one-fourth of the country's population live there, with poor livelihood groups forming about three-fourths of the coastal population. Development and livelihood of coastal people is adversely affected by water related disaster of various nature e.g. tide, cyclone, salinity intrusion, drainage congestion, conflicting land use, arsenic contamination, river erosion, scarcity of fresh water etc. Flood in the coastal region are mainly of two origin, tidal flood and storm surge flood. Management of both of them demands distinct approach.

The coastal area of Bangladesh belongs to the 'Principal Lunar Semi-Diurnal Constituent' that faces two tides and two ebbs in every 24 hours. Coupled with it the 'Perigean Spring Tide' brings much suffering to the coastal zone. When the normal tide and the perigean tide coincides, the overall tidal amplitu

de increases by about 20% than the normal one and inundates more coastal areas for longer duration.



Occurrences of Perigean Tide

On the other hand, most of the storm surge flood occurs during the pre-monsoon and post-monsoonperiod.Major coastal flooding typically occurs in response to strong onshore winds, barometric pressure changes from a coastal storm and heavy rainfall in the coast. If a storm strikes during a perigean spring tide, flooding could be significantly worse than it otherwise would have been.The process is relatively complex and requires combined effort Meteorologist, Hydrologist & Modeler.

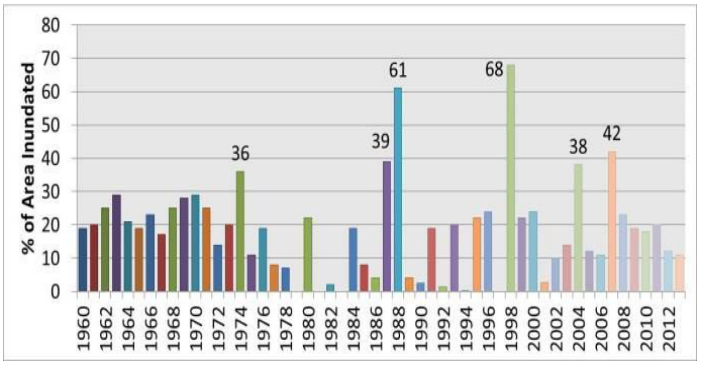
Presently no forecasting system is available for Tidal flood/Storm surge flood; BMD issues tide height forecast (which is in addition of normal astronomical tide height) with Cyclone forecast. Besides, weakness exists in tidal data, storm surge data and wind speed data collection (frequency & quality).Existing flood forecasting models used by FFWC of BWDB has limitation to address tidal flood/storm surge flood. Potential measures to address tidal/storm surge flood might include;

- Establish Tidal flood monitoring & forecasting system especially for Perigean Spring Tide.
- Develop, Improve & Operate (at least experimentally) Storm surge inundation/forecast model jointly by FFWC of BWDB, BMD, IWM and CEGIS
- Translate tide height (in addition to normal astronomical tide) forecast from BMD to consequences.
- Modernize/improve Tidal data, Storm surge data and wind speed data collection.
- Joint effort of BWDB & BMD supported by IWM & CEGIS needed to address the problem.

Other measures that could be thought of are flood proofing, rationalization of coastal polders, equitable allocation of multi-purpose shelters etc. Although many of the tools and techniques are practiced in varying degrees, they need to be integrated. Flood Management decisions can't be successful without giving due consideration to interdependence of land, water, ecosystems and infrastructures.Related institutions, available tools, techniques and knowledge needs to be combined together to combat the problem.

5.14 Presentation by Mr. Malik Fida A. Khan, Director, Climate Change and Disaster Management Division, CEGIS

Reviewing the frequency and extent of flood that occurred in Bangladesh since 1960, Mr. Fida said that there occurred one mega flood in 27 years (1960-1986), whereas during 1987-2013, having the same time span, there occurred 5 mega floods in Bangladesh. This clearly demonstrates that the frequency of occurrence of severe flood has rapidly increased over the last two decades. For managing the country's flood, BWBD has implemented more than 600 water management schemes that collectively protects 5.40 million ha land from damaging effects of flood. Flood management in Bangladesh encompasses a diversified range of activities, both structural and non-structural measures and includes flood control embankments, dams and reservoirs, submersible embankments, regulators, flood wall, channel re-excavation, flood forecasting and early warning system, flood zoning (flood insurance), flood evacuation and shelter management, flood information dissemination etc. Several agencies, both governmental and non-governmental, are involved in managing the floods in Bangladesh. Although Bangladesh has made commendable progress in flood management, there still remain many gaps in



Flood Inundation in Bangladesh

different areas of flood management. Mr. Fida suggested several potential measures that can be thought of for improving and making the flood management activities more effective. Some of the potential measures included;

- Integrated Planning &Design
- Large scale flood forecasting
- Applied Research
- Regional Cooperation
- Technologies and Models
- Strengthening of Information portal
- Training and Capacity Building
- Green Belt Concept
- Exploring Identical Experiences

5.15 Presentation by UmmeKulsumNavera, Professor, Department of Water Resources Engineering, BUET

Bangladesh is a low-laying deltaic country located at the north of the Bay of Bengal and formed by the three major river system of the world. About 80% of the land area is flood plain of the major river system. Its geographical location makes the country vulnerable to flood. Flood is a normal phenomenon in Bangladesh and normal flood is beneficial in different respect, e.g. floods provide fertile silt deposits, recharge groundwater and maintain habitats. However, severe floods bring overwhelming misery and economic damage. Normal floods inundates about 20-30% of the country, which on the other hand, rises to about 60-70% in case of severe flood.

A systematic flood management in Bangladesh date backs to mid-50s, when in 1954 and 1955 two disastrous floods occurred in this region. Following these floods, a mission was launched by UN, widely known as Krug mission. As a follow-up of this mission, a master plan was formulated in 1964 which prioritized structural options for flood control in the country. Soon after the government realized that flood problems could not be mitigated through structural measures, and in 1972 Flood Forecasting ans Warning Centre was establish as a part of non-structural measures for flood management in the country. Following the disastrous flood of 1987 and 88, a comprehensive study was undertaken, known as Flood Action Plan, which culminated in the formulation of Bangladesh Water and Flood Management Strategy, National Water Policy, National Water Management Plan etc. The NWMP emphasized on integrated water resources management principal, and presently the country's flood management follows a blend of both structural and non-structural approach. Under the new flood management strategies, the Government has built almost all the structures of strategic importance for a 100 years flood.

Formulate of a road-map for future requires a critical review of the past activities and achievement. Over the last 60 years of so, beginning from mid-50s, numerous water development plans and projects have been implemented in Bangladesh. A review of them poses several questions;

- How effective the Flood Management and Model software currently are in modeling flows in compartments/sub-compartments?The FAP-25 module showed good performance in modelling flood flows in compartments. The present status of flood forecasting models in modelling compartment/sub-comaprtment flows is unknown.
- Considering future scenarios, how the flood models can be improved to represent the floodplains of Bangladesh more accurately?It is needed to verify the models under this scenario.

- How forecasting performance of flash floods can be improved?The present flash flood forecasting system can't forecast the floods with sufficient reliability
- How the design/redesign of effective drainage system would be carried out to overcome water logging problem for extreme climatic scenarios?Drainage congestion is the most severe problem in the urban areas during floods. Under changing scenarios, the drainage pattern in the urban areas is likely to worsen
- Has the damage due to cyclones and storm surges been reduced or increased in coastal zones compared to past?There is evidence that the coastal flooding situation is worsening

5.16 Presentation by Mr.Md. Sohel Masud, Director, Flood Management Division, IWM

Gaps in Flood Management and Potential Measure utilizing Mathematical Modelling Technique was the theme of the presentation of Mr. Masud. He said that Bangladesh drains a catchment area of about 1.72 million sq.km which is about 12 times larger than its land area, out of which only 7% lies within Bangladesh. At the same the country is criss-crossed by a network of 24000 km rivers. Its geographical location and flat topography makes the vulnerable to flood. For flood management, Bangladesh employs both structural and non-structural measures. Structural measures include dykes, embankments and levee and the non-structural measures include Flood Forecasting and warning, Flood Response and Flood Insurance. Till now BWDB has implemented about 617 water management projects among them about 139 are polders located in the coastal region for managing flood and related hazards in the coastal area. Embankment and drainage regulators are main components of the polders offering protection against tidal floods, salinity intrusion and sedimentation. The primary purpose of empoldering was to increase agriculture production. As a part of flood management activities, Bangladesh effectively utilizes flood forecasting technology with different lead time. The existing 5 days lead time flood forecast is operational at 54 locations most of which are located in the North West, north central and north east region of Bangladesh and also along the Ganges, Jamuna and Padma river. Flood forecast outputs include forecast river water level, depth duration map, vulnerability map, location/structure specific forecast etc. To make flood management more effective, still there remains a long way to go that includes;

- Expansion of the forecasting system to cover all flood prone areas specially the coastal area.
- Detailed forecast at regional / local levels.
- Detailed forecast with respect to infrastructure (highways, embankments, FCD projects, coastal polders).
- Extend lead time to medium term (up to 10 days) and long term (monthly).
- Develop forecast tools for coastal flooding including storm surges.

5.17 Open Discussion

At the end of each technical session, open discussion was held on the presentations for further clarification of different issues presented in the case studies and papers, sharing experience and views, comments and suggestion from the participants for future consideration.

6 PREPARATION OF THE PILOT PROJECTS AND PREPARATION FOR THE FIELD VISIT

After the workshop, a reconnaissance field visit was performed in two polders of Bangladesh Water Development Board, polder no 32 and 33, located in DakupUpazila under Khulna district.

The purpose of the visits was to gain a real-life understanding of the physical setting of the project area, prevailing problems and the way the problems are presently addressed, understanding the general environmental and socio-economic condition based on which the methodology of the pilot study project would be formulated. During the field visit detail discussion was held with local stakeholders, project officials, public representatives and other relevant persons.

Annex-4: Glimpses of the Workshop