Proceedings of International Seminar on Long Lead Flood Forecast Technology for Disaster Management

3-4 September 2008, Dhaka, Bangladesh

Organised by:
Ministry of Water Resources
Government of the People's Republic of Bangladesh

Lead Organisation:
Bangladesh Water Development Board

Technical Partners:
Asian Disaster Preparedness Center (ADPC)
Climate Forecast Application Network (CFAN),
Georgia Institute of Technology, USA
IWM, CEGIS, BMD, DAE and DMB

Development Partners:
United States Agency for International Development (USAID), Bangladesh
SHOUHARDO Programme, CARE Bangladesh

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INTERNATIONAL SEMINAR PROCEEDINGS

LONG LEAD FLOOD FORECAST TECHNOLOGY FOR DISASTER MANAGEMENT

September 2008

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Prepared for SHOURDO Program of CARE Bangladesh
by Asian Disaster Preparedness Center (ADPC)

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International Participants together with the organizing committee at the inaugural session of the International Seminar
3 September 2008

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Executive Summary

Bangladesh Water Development Board (BWDB) has so far achieved 72 hour lead time for the flood forecasting action. Over the years it was felt for a long lead-time so that flood induced losses could be mitigated effectively. BWDB has now developed this technology in its Flood Forecasting and Warning Center (FFWC). The technology is the out come of a research work conducted by Dr. Peter Webster in Georgia Institute of Technology, USA. The Asian Disaster Preparedness Center (ADPC) in partnership with FFWC of BWDB with National partners is testing and validating the technology in Bangladesh.

Initially in 2000-2004 the research works were conducted by ADPC with the support from USAID/OFDA. The result was observed significantly well. In 2006, the Government of Bangladesh through BWDB signed a MoU with ADPC to further continue this work to enhance lead time for flood forecasting and warning system. During 2006-2009, SHOUHARDO program of CARE Bangladesh through USAID supported a program to test and transfer this technology to Bangladesh Government. This also aimed to build capacity for sustainable end-to-end generation and application on long lead forecasts. The model covers three types of forecast schemes- short (1-10 days), medium (20-25 days) and long term (1-6 months). It is observed that the 1-10 days forecasts performed extremely well and two other schemes are still on experiment. This long lead forecast technology aimed to harness the latest advances in weather forecasts and climate prediction by using European Center for Medium-range Weather Forecasts (ECMWF) data, and to explore the possibilities for its application to various sectors, particularly in agriculture. It is to mention here that FFWC already has started flood forecasting for 2008 flood in 10 days ahead.

Five pilot areas namely (i) Rajpur union of Lalmonirhat district; (ii) Uria union of Gaibandha district; (iii) Kaijuri union of Sirajganj district; (iv) Bekra Atgram union of Tangail district; and (v) Gazirtek union of Faridpur district have been selected for testing the application of newly introduced long lead flood forecast information at the community level. The pilot testing of forecast information process entailed capacity building of stakeholders involved in interpretation, translation and communication of probabilistic forecast information to enable them to transform science based information into impact outlooks with response options in actionable languages at the community level. The pilot testing of long lead forecasts revealed that through enhanced disaster preparedness significant socio-economic benefits could be accrued to communities at risk in saving lives and minimizing risks to livelihood systems such as early harvesting to avoid major crop damage, planning of transplanting of rice crops to avoid investment losses , take protection measures for saving assets and livestock, pre-harvesting of culture fisheries, plan for flood response activities at the local government level to support community responses and also take precautionary measures to protect infrastructures.

This experience of Bangladesh was shared through a 2 days international seminar. Experts from International agencies like, National Center for Atmospheric Research (NCAR), USA; International Center for Hazard and Risk Mitigation (ICHARM), Japan; International Center for Integrated Mountain Development (ICIMOD), Nepal; and Asian Disaster Preparedness Center (ADPC) and flood management experts from Bangladesh, Bhutan, China, India, Nepal, Philippines and Thailand shared their experiences on flood forecasting and warning system.

1. Background

The flood forecast technology for disaster preparedness in Bangladesh is developing a series of forecasting schemes to increase lead time of flood forecasting in Bangladesh. These schemes cover short (1-10 days), medium (20-25 days) and long term (1-6 months) time periods integration into the existing model of the Flood Forecasting and Warning Center (FFWC), Bangladesh Water Development Board (BWDB). The Ministry of Water Resources of Bangladesh (MoWR) organized a 2-day long international seminar in Dhaka, Bangladesh, on September 3-4, 2008. to inform the people of Bangladesh and in particular, to the national and international scientific community about the technology achieved in increasing the lead time of flood forecasts from 1 to 10 days and its successful application at the community level.

The seminar provided opportunities for experts from throughout the region to share their experiences regarding flood forecast technology and warning communication for disaster preparedness. The event drew together participants and experts from Bangladesh, Bhutan, China, India, Japan, Nepal, Pakistan, Philippines, Thailand and USA. The list of participants is attached in Annex 3.

2. Workshop Objectives

The objectives of the International Seminar on Long Lead Flood Forecast Technology for Disaster Management were to show case 1-10 days forecast products, share flood forecast applications, share lessons learned in flood forecast dissemination and response and launch the 1-10 days flood forecast technology for disaster preparedness in Bangladesh.

3. Opening Session

The opening session was chaired by Mr Badrul Alam Tarafdar, Additional Secretary, Ministry of Water Resources. Dr C S Karim, Hon'ble Advisor, Ministry of Agriculture and Ministry of Water Resources was the Hon'ble Chief Guest, Mr James F Moriarty, Excellency, the US Ambassador to Bangladesh was the Guest of Honor. Ms Denise Rollins, Mission Director, USAID Bangladesh and Mr Nick Southern, Country Director, CARE Bangladesh were special guests.

3.1 Welcome address

Mr H S Mozaddad Faruque, Director General, Bangladesh Water Development Board (BWDB)

In his address, welcomed all the participants to this international seminar organized by the Ministry of Water Resources with assistance of SHOUHRDO Program of CARE Bangladesh and USAID.

He provided an overview of the hydro-geological situation of Bangladesh and emphasized that as a lower riparian country, is not in a position to control floods, hence its citizens rich and poor alike have to live with floods. These

Welcome speech by Mr. H.S. Mozaddad Faruque, DG. BWDB

floods being recurrent phenomena exacerbate the poverty level.

He also presented a brief background of the Climate Forecast Application in Bangladesh (CFAB) initiative started as a research programme of Dr. Peter Webster, which in collaboration with Asian Disaster Preparedness Center (ADPC) and BWDB was applied for the Ganges and Brahmaputra with technical support from Institute of Water Modelling (IWM) and Centre for Environment and Geographic Information Systems (CEGIS) in running the models and disseminating forecast information. By August 2008, CFAB successfully applied this new technology to provide medium range forecast information, which was being run successfully for the past 3 years from 2006.

3.2 Key Note Speech

'Forecast Experience of Flood 2007 and Launching of 1-10 Days Forecast, for Disaster Preparedness' by Mr. Sazedul Karim Choudhury, PD, PFFWC, BWDB

In his keynote paper presentation on 'Forecast Experience of Flood 2007 and Launching of 1-10 Days Forecast, for Disaster Preparedness' Mr Md Sazedul Karim Chowdhury, Project Director, PFFC, BWDB provided a brief background of Flood Forecasting and Warning Centre (FFWC) established in 1972, and the Climate Forecast Applications for Bangladesh project which commenced in 2000.

The FFWC is responsible for flood forecasting, warning and dissemination of forecasts in Bangladesh, and uses "MIKE 11" (quasi two-dimensional) Flood Forecasting Modelling System that gives river stage forecast of major rivers for maximum lead time of 72 hrs with an interval of 24 hrs.

He mentioned that between 2000-2004, to develop long lead forecasts, BWDB collaborated with University of Colorado and ADPC with support from USAID OFDA. From 2006 to present, BWDB in partnership with ADPC with support from USAID and SHOUHARDO Program of CARE Bangladesh designed this project in collaboration with CFAN and the national partners to continue and operationalize long lead forecast schemes. He said that the 1-10 forecasts has performed significantly well while the other two schemes are under development. ADPC facilitated technology transferred to FFWC in 2008 and capacity building process continues at national and local levels for application of forecast at community level. Discussions were held with Secretary General of WMO for getting ECMWF data directly to Bangladesh.

The improvements achieved due to the long-lead flood forecasts under CFAB:

- → *FFWC able to increase the lead time from 72 hrs to 10 days*
- → *The long lead time based on new forecasts model being run with ECMWF data*
- → *This model performs consistently well and correctly predicted 2007 and 2008 floods*
- → *The flood forecasts provides onset of flood, duration and dates of receding of floods*
- → *1-10 days long lead forecasts provides enough lead time to interpret, translate forecast information to users through established communication channels*
- → *The pilot testing of this long lead forecast information at high risk location revels tangible benefits to the at risk communities*
- → *10 days forecasts at community level and develop 20-25 days and seasonal forecasts.*

He provided details of the performance of the CFAB-FFWC forecasts in the on-going floods, and also details of the response activities undertaken by the institutions and communities due to the increased lead time.

He concluded that the long Lead forecasts are one of the best tools to enhance our adaptation to climate change associated risks at present and in future and that FFWC is committed to carry this process forward.

The way forward recommended by the Key Note Speaker:

- The forecasted area needs to be expanded to at risk areas. This requires fine tuning of 1-10 days forecasts to meet specific needs for community (i.e. farmers, fishermen, etc)
- The probabilistic nature of 1-10 days forecasts needs to be communicated to the users at all level by innovative risk communication tools
- Efforts needed to continue to further develop 20-25 days and seasonal forecast to make it operational
- The government of Bangladesh signed a MoU with Regional Integrated Multi-Hazard Early Warning System (RIMES) facilitated by ADPC to continue the efforts and through this partnership would continue to further refine to provide localized 1-10 days forecasts at community level and develop 20-25 days and seasonal forecasts

3.3 Speech by the Special Guests

Mr Nick Southern, Country Director, CARE Bangladesh

In his speech as special guest, Mr Nick Southern, Country Director, CARE Bangladesh, expressed his happiness to see the international experts who had come to learn and share their country experiences. He also thanked the US government and the USAID for their financial support that made this initiative a reality.

Speech by the Special Guest Mr Nick Southern, Country Director, CARE BD

He mentioned that CARE Bangladesh has been working in Bangladesh since 1949, and through SHOUHARDO activities with communities in the Char, Hoar areas as well as some urban slum areas, has also integrated the long-lead flood forecasts generated through this project. He acknowledged the valuable contribution of the FFWC, IWM, CEGIS and other government institutions in collaboration with ADPC and its international partners. He expressed his hope that the success of the CFAB forecast technology could serve as a model for replication in other countries in the region.

Ms Denise Rollins, Mission Director, USAID Bangladesh

Ms Denise Rollins, Mission Director, USAID Bangladesh in her speech mentioned that floods and disaster management are key issues for Bangladesh and hence formed a particular focus for USAID mission in Bangladesh. She expressed her pleasure with the SHOUHARDO programme of CARE which has invested in this excellent project to enable communities to receive advance information so they can prepare themselves to face floods better.

The FFWC was the eventual custodian of the products and she was delighted to hear that the lessons learned would be shared and to hear that the seminar would also focus on dissemination of the forecast information so that farmers, communities and other users would have more time to manage the floods and reduce their losses. She was also happy to know that the forecast products were tested past few years and that during 2007 the project focused on building institutional networks to ensure effective application of the forecast information. She warmly welcomed all the participants to the international seminar.

Speech by the Special Guest Ms Denise Rollins, Mission Director, USAID

3.4 Speech by the Guest of Honor

Mr James F Moriarty, Excellency, the US Ambassador to Bangladesh

Mr James F Moriarty, Excellency, the US Ambassador to Bangladesh as special guest reiterated the purpose of the flood early warning as saving lives and mitigating disasters, and hoped that the seminar would promote sharing and learning of experiences of technical experts and disaster managers.

He recounted the contribution of US Government to Bangladesh in improving food security and in disaster preparedness, response and recovery activities which assisted over 4 million people in 3000 villages. He also said it is clear that advance information on weather and climate would have a great impact on saving lives and property. This was already witnessed in 2007 when the lead time helped government and non-government agencies in enhancing their preparedness and planning for logistics and relief activities, as well as community level preparedness activities such as preparing and deploying small boats, safeguarding firewood, valuables, possessions, food items etc. He expressed his view that this long-lead forecasting initiative could serve as a model and first step for flood early warning systems in the region. He wished the participants and organizers a very successful seminar.

Speech by the Guest of Honor Mr James F Moriarty, Excellency, the US Ambassador

3.5 Speech by the Chief Guest

Dr C S Karim, Hon'ble Advisor, Ministry of Agriculture and Ministry of Water Resources

Speech by the Chief Guest Dr C S Karim, Hon'ble Advisor, MoA & MoWR

Dr C S Karim, Hon'ble Advisor, Ministry of Agriculture and Ministry of Water Resources, in his address expressed his pride at the presence and participation of the international experts in the seminar. He said that Bangladesh has been living with floods, which is sometimes beneficial but mostly devastating, and that it has been difficult to recoup the losses due to floods at both the macro and micro levels. He illustrated the importance of advance warning in the case of flash flood last year in the case of a farmer who could have salvaged at least part of his crops if he had some lead time.

He praised the resilience of the farmers in Bangladesh who despite a severe loss in Aman crops more than made up the production through a bumper Boro crops. However he also highlighted the uncertainties associated with weather which has severe impacts due to the existing vulnerabilities. He emphasized the need for advance information for enhanced food security especially in a climate change scenario of more frequent and more intense extremes.

He felt that this seminar would be extremely beneficial in fostering a network for operational collaboration among the participants, for sharing information as well as increasing accuracy of forecasting.

Dr. Karim also emphasized the importance of communicating forecast information in a simple, lucid manner resulting in easy comprehension by all users even the communities, and for that interpretation and translation of warning information was vital. In concluding his inspiring address, he thanked the international participants and wished all the participants and the organizers a very successful seminar.

3.6 Address by the Chairperson

Mr Badrul Alam Tarafdar, Additional Secretary, Ministry of Water Resources

Mr Badrul Alam Tarafdar, Additional Secretary, Ministry of Water Resources in his address warmly welcomed all the participants, and also provided an overview of the Ministry of Water Resources, which is majorly tasked with the comprehensive development and management of the water resources of Bangladesh. He also provided an overview of the hydrological situation of Bangladesh and the importance of the flood warning system. He expressed his gratitude to Georgia Institute of Technology, Asian Disaster Preparedness Center for working with the Government of Bangladesh institutions in bringing to fruition the long-lead flood forecasting as envisaged under the Climate Forecast Applications in Bangladesh project. He also wished the participants a successful seminar.

Speech by the Chairperson Mr Badrul Alam Tarafdar, Additional Secretary,MoWR

3.7 Vote of Thanks

Mr Saifuddin Ahmed, Joint Secretary, Ministry of Water Resources

Mr Saifuddin Ahmed, Joint Secretary, Ministry of Water Resources provided the vote of thanks to the Chief Guest, Special Guests for their inspiring words, international and national participants for their presence at the seminar, the organizers for the conduct of the event and the media for their coverage and presence at the event.

3.8 Press briefing

A press briefing was arranged to conclude the inaugural session. The press briefing in both language attached in annex 1.

4 Introduction and Overview

The second session of the seminar focusing on overview of the seminar was chaired by Mr. A R Subbiah, Director of Climate Risk Management and Team Leader Early Warning Systems of Asian Disaster Preparedness Center (ADPC). He said that the CFAB project was designed in a seamless manner through which Science and Technology in the form of long-lead forecasting techniques developed for Bangladesh in collaboration with the national institutions was related to the user communities

Speakers and the Chair for the second session: Introduction and Overview

through an institutional mechanism at the national and sub-national and local levels.

He said that the second session of the seminar would have three groupings of presentations- the first focusing on the science aspects, presented by Dr.Jayaraman KV Potty on behalf of Dr.Peter Webster, the second would focus on relating the scientific information as per user requirements and dissemination of such useable information which would be covered by Mr Abu Saleh Khan, IWM and Mr Ahmadul Hassan of CEGIS, Mr. S.H.M. Fakhruddin of ADPC and finally the user or community response as seen in the case of the on-going floods in Bangladesh presented by Mr. Atiq Kainan Ahmed of ADPC.

4.1 Assessment/ Lessons Learned in Generation of Long Lead Flood Forecast Products

Dr Jayaraman KV Potty, ADPC, Mr Abu Saleh Khan, IWM and Mr Md Saiful Hossain, BWDB

Dr Jayaraman KV Potty provided the participants with introduction of the scientific aspects of the development of long-lead forecast for Bangladesh. He walked the participants through the specific challenges that the scientific approach had to overcome with managing floods in the lower riparian country due to very large catchment areas of Ganges and Brahmaputra rivers being outside Bangladesh.

He shared the approach to address the problem of catchment precipitation forecasting, a nest of physical models are developed that depended on satellite data, forecasts from operational centers (e.g. ECMWF) and statistical post-processing. Through the CFAB project forecast of rainfall and precipitation in probabilistic form is updated every day, and provided probability of flood level exceedance at the entry point of the Ganges & Brahmaputra, which is useful for emergency planning, and selective planting or harvesting to reduce potential crop losses at the beginning or end of the cropping cycle. It is also incorporated to drive Bangladesh routing model (MIKE) resulting in extending the 2-3 day Bangladesh operational forecasts to 12-13 days.

He outlined the scheme as follows:

- The short-term prediction scheme depends on the ECMWF daily ensemble forecasts of rainfall, and thermodynamical variables over the Indian Ocean, Asia and the Western Pacific Ocean
- Forecasts are corrected statistically to reduce systematic error
- Rainfall introduced into a suite of hydrological models which allow calculation of G&B discharge into Bangladesh
- Statistical probabilities are then generated

The approach comprised of the key steps of initial inputs, statistical rendering, hydrological modeling, generation of probabilistic forecasts and inputs from users for applications. This ensured that multi-model Ganges and Brahmaputra discharge forecasts for 1 to 10 days are arrived at.

Mr Abu Saleh Khan, IWM assessed the forecasts as well as the lessons learned during the past years on the long-lead forecast technology. His presentation covered the current flood forecast by FFWC, overview of the project, its collaborating agencies and the methodology used to customize CFAN data for use in FFWC model, and evaluation of the forecast of 2006-2008 as well as the way forward.

The major conclusions were as follows:

- The quality of forecasts inside Bangladesh is largely influenced by forecasts at Bahadurabad and Hardinge Bridge points supplied by the CFAN.

- The forecasts inside Bangladesh territory is also dependant on the state of CFAB-FFS model calibration and the physical changes that have taken place after 1999-2000 hydrological year.
- The CFAB-FFS model has been customized from FFWC Super Model developed on 1999-2000 hydrological year.
- Analyses and evaluations have shown that the ensemble mean has provided the best forecasts during 3-, 5-, 7- and 10-day forecasts both for Bahadurabad and Hardinge Bridge stations.

4.2 Flood Forecasting Dissemination and Community Response

Mr Ahmadul Hassan, CEGIS and Mr S H M Fakhruddin, ADPC

Mr.Ahmadul Hasan, CEGIS provided a brief background of the CEGIS involvement in the project, with major targets being site selection, vulnerability analysis, assessment of user needs, dissemination of information in demonstration sites and coordination with other flood management-related initiatives.

Suitable sites were selected based on Biophysical criteria (riverine flood prone area, climate/ hydrological data availability, accessibility, availability of FWC forecast data) and Social criteria (demand from the user, per capita food grain production, literacy,population exposed to the flood hazard).

The baseline studies identified the following key findings:

- All pilot sites are affected by flood every year
- Affected sectors are agriculture, fisheries, homesteads and Infrastructures
- Special affected sectors is looms in Sirajganj
- Existing early warning is not in local context and not helpful to the community
- People wants long term flood early warning with local context
- People prefer microphone, TV, radio, flag and mobile phone technologies for information dissemination.

Analysis of Flood Vulnerability of the community involved identification of flood affected areas with respect to depth, installation of flood pillar with demonstration of flood level, use of satellite image of different flood and year (field validation) and preparation of relative flood risk maps.

The CFAN forecast was then translated for the community using flags. SMS through mobiles was used to pass information to flag sites for hoisting flags. The key dissemination nodes were the UDMC & CBOs, flag sites and households. Warning levels correlated to the water level being above or below the danger level and the flood intensity helped communities develop appropriate response options. The communities and users were further trained in applications of the forecast information.

He also presented key findings of the assessment of the response during the floods of 2007 as very satisfactory due to concrete response measures taken by the communities in reducing potential losses.

4.3 Pre-Flood Preparedness Assessment: Experiences from ongoing 2008 flood in Bangladesh

Mr.Atiq Kainan Ahmed, ADPC

Mr.Atiq Kainan Ahmed presented an assessment of the pre-flood local level preparedness during the ongoing floods in August- September 2008. The assessment also facilitated sharing of updated flood forecast information at local level with partners, observed how people and agencies respond to the forecast information at local level (including their mindsets), the flood forecast "information flow" to the local level, and undertook a rapid identification of some likely impacts and documented the people's pre-flood preparedness and response actions.

The team comprised representatives from ADPC, CEGIS, CDMP(DMIN project team members) and FFWC which teamed up with local partner NGO representatives and networked with District Administration focal points for DRM (DRRO>PIO), local government (UP Chairman and members for pilot sites), local contact points of CFAB program at pilot site, local flag operators at pilot site level and selected Government departments and line agencies at District and upazila levels (e.g. DAE, Livestock etc).

The likely impacts were anticipated as below:

Agriculture:	Economic and social impacts:	Livestock and fisheries:
• T-Aman damage (standing crop) • Likely shortage of seedling • Seedbed damage • Loss of fertilizer that has already been used in T-Aman cultivation • Hindrance in jute processing • Summer vegetable damage • Homestead garden damage	• Crop loss • Shortage of employment • Price hike of consumable goods • Homestead shifting • Disease outbreak • Infra-structural damage	• Animal deaths • Shortage of fodder • Animal disease • Loss of capture fisheries • Difficulties in transporting domestic animals and fish

Key observations on the flow of forecast information were as below:

Availability

- 48 hours forecast: District level and agency level
- 4-days lead-time delivery: Found at pilot areas only
- 10-days lead-time delivery: Availability but great need expressed
- Flood news has also reached through TV and Radio

Dissemination systems

- SMS based notification: operating; sent to nodal points at pilot community
- Flag hoisting: operating; UP involved; some ambiguity when downscaling the warning
- Flood information bulletin: great demand expressed for an understandable and more context based information. Need expressed for bulletins relating to livelihoods preparedness.

Local level information flow

- Faster from FFWC to BWDB offices and CFAB to Pilot communities
- Very slow from District to Upazila and lower levels
- Inter-agency horizontal sharing of information at district level is there but takes time
- Low manpower and technical capacity of line agencies observed to flow the flood information further in a rapid manner

About the local perceptions and the mindset of the community the assessment found that people adopted "watch-wait-work" attitude (remained reactive in some cases to the river water observations and constantly referred to their past/experiences and were found willing to store/move into "trusted, most safe locations". People also associated flood occurrences with the "lunar position of moon" while UPs in pilot areas held meetings (informal/formal) and some people took actions (e.g. delayed transplantation, stored seedlings etc)

With regard to the agency responses, the team observed that interaction with local BWDB offices for WL and flood information was present but low capacity observed to take that information further and more localized forecast is sought than the generic ones available. Agencies also prepared more for response/relief and recovery actions while immediate responses are constrained by administrative bindings. There was great willingness to receive 10-days forecast information and that it can give agencies more time for coordination and put in departmental requests for preparedness.

The community responses encompassed protection of seedbeds, preservation of seedlings, protection of culture fisheries using nets, relocation /resettlement of houses, storage of animal fodder in safe places, preparation of safe places for household goods, embankment side temporary shelter, relief material storage in the union level and moving cattle away from risk areas.

The recommendations that emerged based on the pre-flood preparedness assessment are that 10-days forecast system availability is crucial for livelihoods preparedness and also for agency preparedness, capacity to interpret, translate and communicate probabilistic forecast information with impact outlooks with response options at various levels are crucial, location specific "impact and response option bulletins" needs to be developed, agency level preparedness SoPs based on probabilistic forecast needs to be developed for livelihoods risk reduction., requirements of special groups (e.g. handloom workers) and people of special needs are considered, and a feedback information flow from communities to forecast information providers should be established.

4.4 Discussions and Recommendations

A lively discussion followed the presentations with the participants posing some queries to the presenters.

Mr. Md. Sarafat Hossain Khan, Executive Engineer of BWDB asked the panel about the mathematical model for the flash flood region for Bangladesh and additional clarification on the dissemination (language, mode and responses from communities). The panel responded that the present CFAB model was applicable for monsoon flooding only and not for flash floods, which could be managed by using Doppler radars and weather models. On dissemination, the panel said it would be easy if the impact on different sectors is available so that appropriate response options could be identified. Further it is difficult to convey such information directly from national level to users, and would better if capacity is developed at the intermediary levels to disseminate and use probabilistic information. On the language, the message has to free from scientific jargon and easily understood by the communities.

Mr. Md. Abu Sadeque, PEng, Director of DMB, reacting to a panel presentation on the CFAB forecast, expressed his opinion that the forecast skills need to be improved if the RMS value is as low as 0.3, and that it was not necessary for CEGIS or IWM to disseminate forecast information since the DMB was now mandated to disseminate all warning information.

Mr. John McHarris, WFP, enquired as to how different the locally set warning levels from the FFWC nomenclature of danger levels. The panel responded that these levels were based on local perspective but were not very different to the FFWC danger levels.

In response to queries from Mrs. Mandira Shrestha, ICIMOD, the panel responded that probably the 2008 forecasts had lesser skills than 2007 since the 2008 ratings of two key stations were probably not incorporated or updated into the CFAN. Also that Brahmaputra discharge forecasts ought to have better skills, compared to the Ganges which was more regulated, but even they could not explain why the model performed better for Ganges.

An opinion was shared by Project Director of PFFWC, Mr. Sazedul Karim, that it was better as seen in the aftermath of SIDR, that training could be imparted directly to the community to interpret and translate warning information for their appropriate use.

Mr. M. A. Matin, former Chief Engineer, BWDB, shared his opinion that the users needed not the exceedance from the danger level, but an indication of whether it was a rising trend or a decreasing trend and more accurate information on duration it would rise or fall. He also mentioned that it was not only agriculture that was affected but also transportation, schools, markets and so the community response system has to incorporate these aspects too, and there already there is a system of communicating information which could be further strengthened. He said that since the 10 day forecast was probabilistic, it was better to use standard deviation of +/- 2 instead of +/- 1.

Mr. Guna Paudel, Danida suggested that it was equally important to focus on basic modeling of downstream, and not just on upstream modelling. Mr. Tauhidul Anwar Khan of Joint River Commission suggested that it was better to disseminate the 10 day forecasts to the communities for them to understand and analyze the information. He also opined that it is important to cover flash floods which are also devastating, and it was vital to develop a digital elevation model for the entire Bangladesh to be able to model better. Further he said the danger levels of different rivers have to updated and re-designated to account for the topographical changes, and it was vital that the danger levels at the local and national levels were matched and agreed upon.

Mr. Sharif Rafiqul Islam, former DG of BWDB welcomed the long-lead forecast but expressed his doubt if it was really possible. It was also important that the impacts of tides are considered on the forecasts which might affect the flood levels even if the upstream forecast is accurate. He also expressed doubts about the indicative nature of the forecasts and it was important to be very serious and conscious about the long-lead forecasting accuracy.
Other vital issues raised by the floor related to the necessity of overcoming shortcomings in the long-lead forecasts which was wanted by the communities, and the importance of local level perceptions and understanding. The importance of assessing demand vs. supply was also highlighted and the forecasts had to meet particular demands after due surveys were conducted. A system of ensuring assessment by all users not just government officials of the long-lead forecast every year was also recommended.

In concluding the session, the Chair Mr. AR Subbiah thanked the presenters for their informative presentations and also the participants for their keen interest and posing queries which led to very animated discussions and in identifying ways of improving the CFAB initiative.

5 Sharing Experiences: Flood Forecasting Technologies

The third session on sharing experience on flood forecasting technologies was chaired by Mr H S Mozaddad Faruque, Director General, Bangladesh Water Development Board and Mr. Mukhlesuzzaman, former Director General, Bangladesh Water Development Board. The session comprised of presentations by Dr Jayaraman KV Potty, ADPC on Flash Flood Forecast Technology, on Water Hazard and Risk Management by Dr Kazu Fukami of

Speakers and the Chairs for the third session: Flood Forecasting Technologies

ICHARM, Japan, Rainfall Estimation in GBM by Ms Mandira Shrestha, ICIMOD and on Multi-Model Discharge Forecasting Technology by Dr Tom Hopson, NCAR followed by discussions and recommendations.

5.1 Flash Flood Forecast Technology

Dr Jayaraman KV Potty, ADPC

In his presentation Dr.Potty provided an overview of flash floods in Bangladesh which occur during Pre-Monsoon (April, May) and Post-Monsoon (September, October) periods every year.

These flash foods are triggered by high intensity rainfall in neighboring Indian catchments located in the Meghalaya and Tripura hills. Flash floods are flood events where the water level rises rapidly after a rainfall event, typically within a few hours. Rainfall intensity and the hydrology of the catchments are important in flash flood dynamics. Given amount of rainfall in a given time may or may not result in a flash flood, owing to such factors as antecedent precipitation, soil permeability, terrain gradients and so on. By identifying the cause of flash events in a given area, it is possible to relate water level variation to the catchments rainfall by the equation: q = $f($ rainfall, soil characteristics, terrain gradients)

He presented a case study of a squall which passed over Kolkata in May 2007, and the numerical modeling which was able to simulate with reasonable accuracy the temperature, relative humidity, rainfall and wind speed. Thus the WRF model would be capable of predicting with some lead time the resultant rainfall from thunderstorm activities which could then be used for hydrological modeling of flash flood. He also finally presented the configuration of the high performance computer at the regional early warning facility, facilitated by ADPC.

5.2 Water Hazard and Risk Management

Dr Kazu Fukami of ICHARM, Japan

Dr Kazu Fukami of International Centre for Water Hazard and Risk Management (ICHARM), Japan in his presentation on the current status of flood forecasting and warning in Japan focused on the collection, processing and provision of real-time data, including the implementation of the uniform river information system, provision of flood-disaster risk information, rainfall forecast, runoff analysis and flood forecasting and also the introduction of ICHARM, and an outline of its activities. He also introduced the Integrated Flood Analysis System (IFAS) and touched upon utilization of satellite-based rainfall information for flood management as a proposal for poorly-gauged river basins in developing countries.

Dr.Fukami elaborated on the types of flood warning in Japan. The joint announcement for a specific river by Japan Meteorological Agency (JMA for weather, rainfall forecast and information) and Ministry of Land, Infrastructure, Transport and Tourism (MLIT for river information) covers Flood Advisory information, Flood Alert Information, Flood Risk Information and the actual Flood Information.

In addition, the regional flood warnings issued by JMA for a wider region of local district, often including multiple rivers, announced by the local meteorological observatory of JMA in its area of administration for medium- to small-size rivers other than those designated for flood forecasts has the following nomenclature:

Weather advisories	Announced when disasters may occur by heavy rain, gale, high tide, etc.
Weather warnings	Announced to warn of a risk of serious disasters by heavy rain, gale, high tide, etc.
Flood advisories	Announced when floods may cause damages
Flood warnings	Announced to warn a risk of floods

The warnings for flood fighting issued by MLIT are for a specific river and/or some sections of it and announced by river managers such as MLIT or the prefectural government to provide flood-fighting organizations with a guideline for their activities.

Standby	Alerts that flood-fighting organizations need to be ready for operation in case floods may occur or WL is predicted to increase.
Preparation	Warns that flood-fighting organizations need to be prepared for operation, at the same time, sending information about flood control, providing flood control equipments and materials, securing communication and transportation means.
Mobilization	Warns that flood-fighting organizations need to be mobilized when WL is predicted to exceed the Flood Alert WL.

He also introduced ICHARM established under auspices of UNESCO as a centre focusing on research, training and information networking.
Dr.Fukami also presented the necessity of satellite-based rainfall data especially for poorly gauged river basins in developing countries, and the key features of such a system in Japan, and compared accuracy of gauged precipitation with satellite-based precipitation. In his presentation on the development of IFAS: Integrated Flood Analysis (or Alert) System, as a platform for flood forecasting system in developing countries, he introduced the computer software package specifically for flood runoff analyses with GUI using ground-based and satellite-based rainfall data being developed by a joint research (FY 2005-2007) at ICHARM/PWRI, Infrastructure Development Institute, (IDI/IF-Net), and nine major civil-engineering consulting companies.

5.3 Application of Satellite Rainfall Estimation in the Himalayan Region

Ms. Mandira Shrestha, ICIMOD

Ms Mandira Shreshta of Integrated Water and Hazard Management International Centre for Integrated Mountain Development (ICIMOD) in her presentation on 'Application of Satellite Rainfall Estimation in the Himalayan Region' provided an introduction to ICIMOD and HKH region, disasters in the Himalayas- floods, flash floods, landslides, glaciers/glacial lakes; satellite rainfall estimation and its application in rainfall-runoff model, ICIMOD's role in Flood Risk Reduction and finally the constraints and opportunities in DRR.

She highlighted the key issues as transboundary rivers, lack of exchange of timely real time data especially across national boundaries, not adequate lead time, diversity of technical, scientific and institutional know-how, existence of bilateral agreements/treaties and beginning of regional mechanism.

She also justified need for satellite rainfall estimate due to the sparse density and inadequacy of hydrometeorological stations, delay in real time data transmission, inadequate lead time – absence of data sharing across transboundary borders and introduced the NOAA CPC RFE2.0 rainfall estimation.

She presented validation of the rainfall estimation through visual analysis, scatter plot of observed vs. estimated rainfall, descriptive statistics through contingency tables use of POD and FAR, statistical

analysis using bias, RMSE, Correlation, Skill, % error etc. Ms. Shreshta presented cases of satellite rainfall validation in Nepal, Bhutan, Bangladesh, and for recent events such as Myanmar cyclone of May 2008 and Pakistan floods in July 2008.

Ms.Shreshta also presented rainfall distribution in the Brahmaputra basin as predicted by the RFE, observed and GeoSFM simulated flows of the Brahmaputra River at Bahadurabad. She identified the next steps in application of satellite rainfall estimation as- reduction of lag time of data, improving orographic effects in rainfall estimation, and the maximum availability of the raingauge stations since for RFE, the shape of precipitation is given by the combination of satellite estimates while magnitude is inferred from GTS station data, including radar data for validation where available in HKH and incorporation of more gauge data for validation, validation considering different rainfall regimes, and temporal variable like decadal, monthly, yearly, rainy season etc using different spatial resolution (0.25°, 0.5°, 1°, etc), and application of improved RFE in flood early warning and flood monitoring activities in flood season.

5.4 Daily to Seasonal Operational Flood Forecasting

Tom Hopson, NCAR, Peter Webster, CFAB and Georgia Tech, A. R. Subbiah, ADPC

Dr. Tom Hopson of NCAR in his presentation on daily to seasonal operational flood forecasting provided an overview of daily to seasonal weather forecast products, seasonal forecasting and short-term forecasting: Bangladesh CFAB example especially on predictability, precipitation forecast bias removal, multi-model river forecasting and accounting for weather and hydrologic errors as well as future work such as through collaboration with Dartmouth Flood Observatory.

He highlighted the forecast products for hydrologic applications, ranging from the Seasonal ECMWF System 3 to monthly forecasts of ECMWF, medium-range ECMWF EPS and the Short-range RIMES information at 9 km resolution. He mentioned that the good forecasting skill of CFAB forecast derived from good data inputs: ECMWF weather forecasts, satellite rainfall, large catchments in which weather forecasting skill "integrates" over large spatial and temporal scales and partnership with Bangladesh's Flood Forecasting Warning Centre (FFWC) and use of daily border river readings used in data assimilation scheme

He elaborated the steps involved in rainfall inputs- Rain gauge estimates: NOAA CPC and WMO GTS, Satellite-derived estimates: NASA TRMM, Satellite-derived estimates: NOAA CPC "CMORPH" and Weather forecasts: ECMWF GCM 51-member ensemble weather forecasts at 1-day to 15-day forecast lead-times.

His presentation also detailed transforming (Ensemble) Rainfall into (Probabilistic) River Flow Forecasts, discharge Multi-Model Forecast and multi-Model Forecast Regression coefficients, the significance of weather forecast uncertainty discharge forecasts.

He also presented the Satellite-based River Discharge Estimation by Dartmouth Flood Observatory and its application in the Ganges river basin. He concluded that in 2003 CFAB Brahmaputra/Ganges forecasts went operational, in 2004 the forecasts were fully-automated, and the severe Brahmaputra flooding event was forecasted, while in 2007 the 5 pilot areas warned many days in-advance during two severe Brahmaputra flooding events. The future work could include assimilation of Dartmouth Flood Observatory river discharge estimates for improved skillful long-lead forecasts, and application of fully-automated forecasting scheme relying on global inputs (ECMWF forecasts, satellite rainfall) rapidly and cost-effectively to other river basins with in-country capacity building.

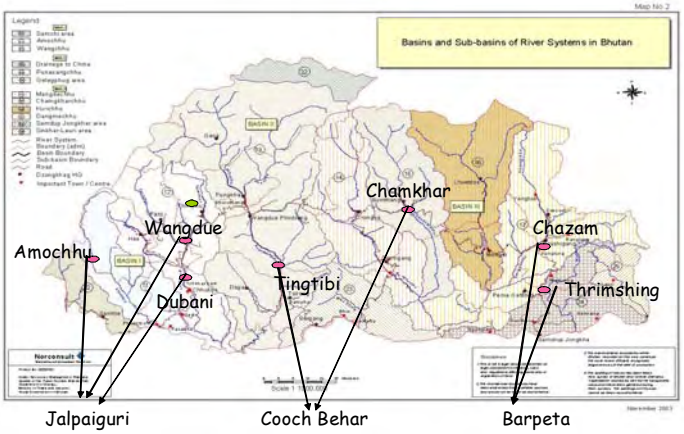
6 Country Presentations: Flood Forecasting and Warning System

The session on the country presentations focusing on flood forecasting and warning systems was chaired by Dr Kazu Fukami ICHARM, Japan. The session included presentations by Bhutan, China, Thailand, India, Nepal and the Philippines, followed by discussions.

6.1 Presentation by Dr Karma Chhophel, Bhutan

Dr. Karma Chhophel, Hydro-met Services, Department of Energy of Ministry of Economic Affairs, Bhutan presented the Flood warning system in Bhutan. His presented covered the background, river systems, floods in Bhutan, existing facilities, new initiatives and future activities.

Bhutan is endowed with abundant water resources of good quality, major rivers flow from north to south with source in the alpine zone. There are large volumes of flow in monsoon and snowmelt at the end of dry season and information on groundwater is scarce as exploration and development in infancy.



Flood Warning Stations in Bhutan

Floods in Bhutan are due to intense rainfall, landslide dam burst, Glacial Lake Outbursts. He provided a background of GLOFs and floods in the recent past. The Flood Warning Section under Hydro-met Services Division, Department of Energy is responsible for providing flood warning services. There are flood warning stations on all north south flowing rivers, which are equipped with HF wireless sets and as back up some stations have telephone lines. Water level information is transmitted to Central Water Commission stations in India and downstream stations in Bhutan.
Thanza Warning Station for GLOF is equipped with Wireless set and a Thuraya satellite phone, and water level at the junction measured every hour and transmitted to stations in India and Bhutan. Two stations in Bhutan are on round the clock watch.

Future priorities include establishment of a Flood Forecasting Centre, a Real Time Warning System in Punakha Wangdue Valley and application of SRE and GeoFSM for flood forecasting.

6.2 Presentation by Dr Li Zhou, China

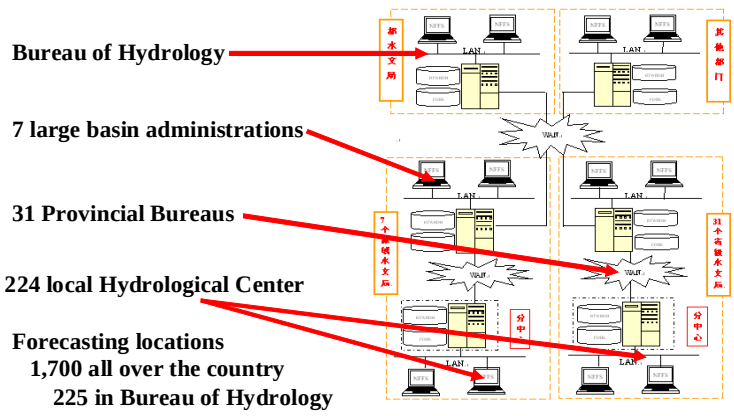
Dr.Li Zhou of China, presented the National Flood Forecasting System (NFFS) in China. NFFS has been developed by the Bureau of Hydrology , Ministry of Water Resources (MWR) in association with related universities and scientific research academies, and operational sectors during the past 8 years. It is based on the design requirements of the National Flood Control Command System project and existing status of hydrological information and forecasting in China. The NFFS has been developed in Client/Server structures, relying on the real-time hydrological information database and GIS platform.

The NFFS was constructed using standardized and advanced software and hardware. The modular and open structure allows easy addition of new models and procedures. It contains common

forecasting models and a methods library allowing prompt building of forecasting schemes. It has built-in functions of model parameters calibration that combines manual trial and error, and automatic optimization methods. The user can easily intervene in any real-time forecasting processing by using the graphical and tabular interface.

Additionally, the NFFS has the powerful ability to compare the results of multi-models and multi-schemes. Therefore, as a uniform and integrated as well as facile national real time flood forecasting system., it can efficiently process large amounts of hydrological data to produce forecasts at hundreds or thousands of locations.

Since 2002, the NFFS has been extended and applied to flood forecasting sectors of BOH in 16 provinces and 5 large river authorities as well as 224 local hydrological centers in China. it has significantly improved the modernization level of flood forecasting in the entire country and reduced local flood losses, and provided considerable economic and social benefit in recent years.



Framework of the System Network for flood forecasting in China

NFFS was developed using GIS, which has a powerful capacity to display river, topography, basin or district boundaries, gauging station distribution and more through electronic map management. Using the GIS based map at the scale of 1:250000, the user can integrate all forecasting schemes for specific basins or districts and query hydrological information, flood forecasting information and station information, zoom, and so on.

NFFS adopted a modular structure for Flood Forecasting Model-base, which can be independent of system and could be developed by a number of individuals. The user can easily add new models and methods based on standard files and common forecasting models. They can flexibly select a set of models and methods to build a forecasting scheme for any basin. Real Time Hydrological Information Data Base comprises the third main component. Dr. Zhou provided additional information in a detailed powerpoint and a video for interested participants.

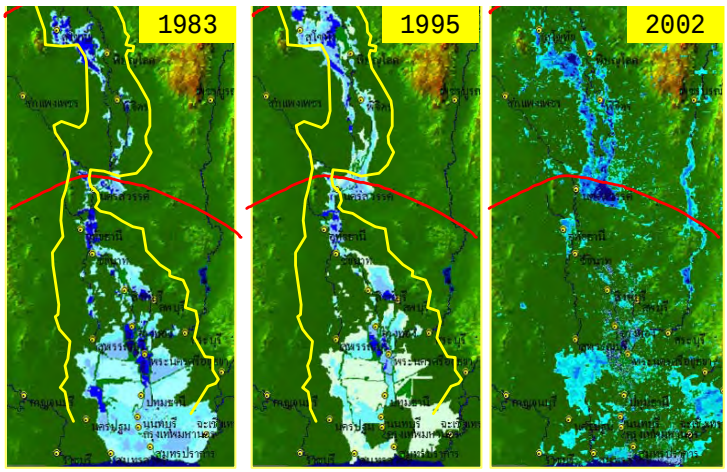
6.3 Presentation by Mr Suvanpimol Pongsthakorn, Thailand

Mr. Pongsthakorn Suvanpimol, Expert on Hydrology, Royal Irrigation Department of Thailand presented the Flood Forecasting and Water Resources Management in Thailand. Thailand is situated in the South East Asia Peninsula. The country covers 511,362 sq.km. with 62 million population, 25 Major river basins and average annual rainfall 1,573 mm., annual runoff 213,423 mcm., total paddy fields 10,224,966 ha., irrigated area 4,476,800 ha. Several additional thunderstorms, depression and typhoon from West Pacific Ocean and cyclone from Andaman Sea are experienced every year. The influence of monsoons and additional rainstorms from both sides of the country caused flood following by extended drought period in some part of the country year by year for non storage dam.

With the high climate variation, gasoline crisis effected shortage and price of agricultural products especially for rice. Rapid increasing paddy fields land use over the country in irrigated and rainfed areas with high extra water demand from the normal year.

The initial appropriate long lead and accuracy of meteorological climate or seasonal forecast related rainfall and effected location is the most important key for reduction on property damages, farm products, economics, life losses from flooding and rehabilitation cost.

Royal Irrigation Department is in charge of water resource development for various aspects as well as water hazard protection and mitigation, flood water management and supply water for agricultural area for better quality farmer's life, raise income, water works, industries and sustain the environment. To mitigate the water hazards, Royal Irrigation Department applies both structural and non structural measures. The existing storage dam with 74,378 mcm., optimization reservoir operation efficiency equip with non structural measures approaches, retarding ponds, Unit- Hydrograph, Stage Correlation and Flood Model with 13 large existing telemetry systems are established and on planning the telemetry system cover 12 river basins with the suitable hydrological net work at least early flood warning 6 hours leading time is quite acceptable for key communities and projects from the alert to severity level of warning to the target audiences for hazard reduction with the most effective communication technology and providing all necessary rescue equipment.

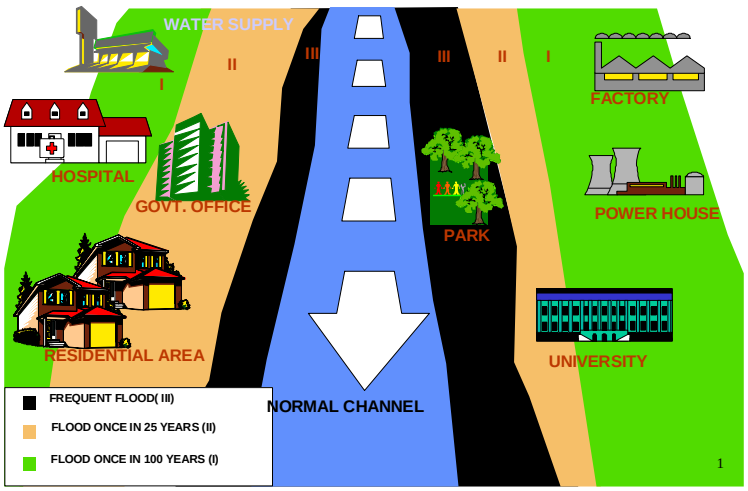


Lower Chao Phraya River of Thailand Flooded 1983,1995 and 2002

6.4 *Presentation by Shri S K Banerjee, India*

In his presentation, Shri S K Banerjee of IMD highlighted India's vulnerability to natural hazards due to its geo-political location. He provided a background of flood forecasting in India.

After the heavy floods in 1954, national policy on , "floods in the country" was set up in 1954 by Government of India which provides measures of flood control and its protection. The Central Flood Board was set up in 1954. Central Water Commission (CWC) was established in 1958.
India Meteorological Department (IMD) and Central Water Commission (CWC) are working in close co-ordination for issue of flood forecasts. IMD has 10 flood meteorological offices located in different flood prone river basins and CWC has 20 flood forecasting divisions. He also provided the nomenclature of floods in India, and impacts of floods on the national economy, and extent of flood prone areas in each state which were protected by structural measures.



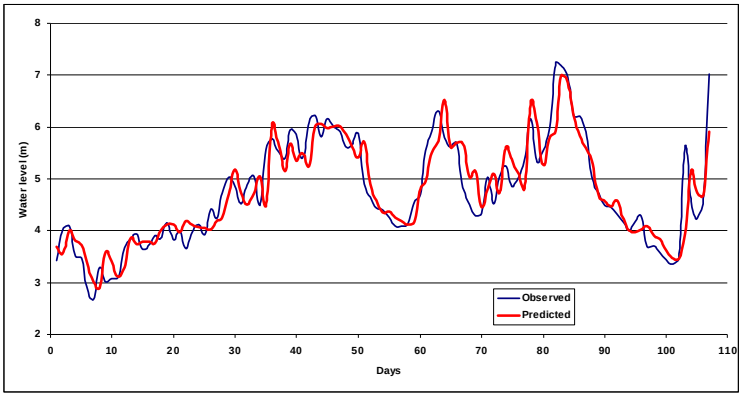
Flood Plain Zoning Concept in India

He provided details of types of flooding in India, and a case of coastal flooding, as well as the recent floods in Bihar state due to change in Kosi river course. His presentation covered some of the challenges in issuing flood forecasts. He also detailed the meteorological causes of floods in India such as shifting of monsoon trough to foothills of Himalayas, monsoon depressions, land lows, cyclones, severe thunderstorms, storm at estuary of river. He provided case of urban flooding in Mumbai in 2005. Dr.Banerjee introduced a new project for improvement in rainfall estimation and prediction by using NWP model outputs and other observations with a pilot for the Mahanadi river basin.

6.5 Presentation by Mr Dilip Gautam, Nepal

Dr.Dilip Gautam, of DHM Nepal presented 'Extreme Floods and Flood Forecasting in Nepal'. He defined flood as "High Flow" for the purpose of modeling, as "Inundation" for the purpose of management. Catastrophic floods could be defined as floods that give rise to inundations, which have very large impact in terms of life and property losses and major disruption to infrastructure. Based on recurrence interval, floods could be classified into the three severity classes of large flood: recurrence < 20 year, very large flood: 20 year < recurrence < 100 year and extreme flood: recurrence > 100 years.

He highlighted the natural and anthropogenic causes of floods in Nepal. Natural causes included fragile geological conditions, extremities in climates, topographical extremities and seismic activities. Climatic factors of flooding in Nepal were heavy rainfall (monsoonal rain, brief torrential rain), snowmelt, ice jam breakup (GLOF), avalanche, landslides etc. He provided details of a very severe flooding in 1993 due to very heavy rainfall in Tistung.



Artificial Neural Networks (ANN) model are being used at DHM of Nepal for flood forecasting

He highlighted anthropogenic causes of flooding such as socio-economic changes- population growth, poverty and illiteracy, deforestation, unscientific agricultural practices, unscientific land use changes and developmental activities- roads, irrigations, hydro-powers, urbanization. Flooding may also occur due to breach of dams and levies either by overtopping or by piping (e.g. Breach of embankment in Koshi River). Flooding may occur due to congestion of drainage (e.g. flooding near Nepal-India border due to construction of embankment on Indian side).

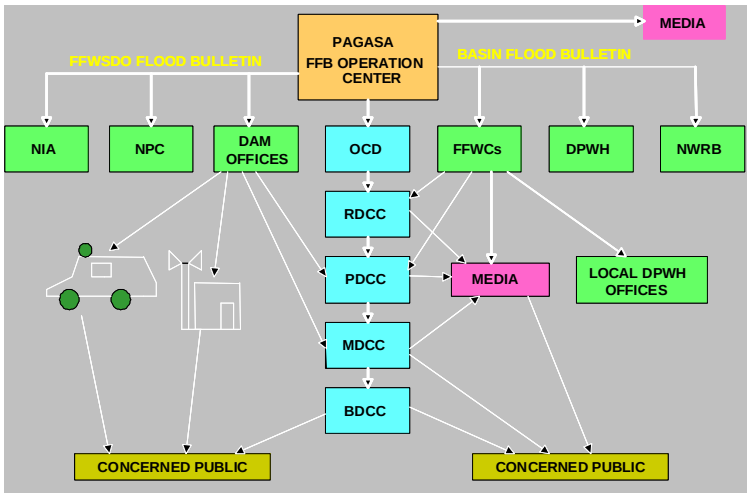
He illustrated historical extreme floods as in Bagmathi River in 1993- the flood discharge of Bagmati River at Karmaiya which usually varies from 2000 m3/s to 16000 m3/s, and in a catastrophic very large flood (16000 m3/s) in 1993, which has the recurrence interval of about 100 years; of East Rapti Riverin 2004, Narayani river in 1974 and 1999, Sapta Koshi river in 1980, West Rapti river in 1977, 1981, 1983, 1999 and 2003

In concluding, he said that DHM needs to further build its capacity in the field of modeling and generation of a suite of high-resolution flood and weather information. And that there should be a real time data acquisition and transmission system for water level and rainfall data so that the performance of the forecast model could be improved by data assimilation techniques.

6.6 *Presentation by Dr Oskar Cruz, Philippines*

Oskar D. Cruz, Weather Facilities Specialist of PAGASA, presented the Flood Warning System and Flood Preparedness in the Philippines.

He highlighted the reasons for Philippines' prone-ness to floods as due to Weather Systems such as Tropical Cyclones, ITCZ, Southwest Monsoon, Northeast Monsoon, Thunderstorms, Easterly waves and Tail end of cold front; and geo-morphology. He provided details of the cumulative damages due to floods in the Philippines.



Existing flood bulletins dissemination schemes by PAGASA, Philippines

Flood Forecasting and Warning System (for River Basins and Dams) in the Philippines was also described, including the facilities, networks and the nomenclature of flood warnings and alerts.

He also shared with participants the community-based flood early warning systems in place in the Philippines.

7 Seminar Findings and Recommendations

Based on the discussions and presentations the seminar summarized the findings and recommendations. Those were presented in the closing session. The recommendations were as follows:

1. Increased vulnerability to floods demand further leads time to reduce risk of damage in Bangladesh. The CFAB development towards 1-10 days forecasts demonstrates promising result on the 18 forecasts locations. The program to cover all flood prone areas deserves continuation of the initiative;

2. Accuracy shown at various stations of the major rivers need improvement. This will require incorporation of the influence of basin level information both outside and inside of the country;

3. There is an urgent need for transfer the modelling technology to Bangladesh institutions to take over the development, validate further improvement and offer back-up support to FFWC;

4. One of the important area of climate forecast technology i.e Climate model could not be developed due to budget constrain; immediate arrangement is needed for development of climate model with full involvement of local institutions;

5. There is a demand for local level dissemination and response for update of total flood management systems; the program should consider areas within flood management infrastructure in addition to areas outside the protections. Packaging of forecast information including guidelines and methodology to use the forecasts would be an important activity

required for the managers of water management infrastructure (embankment) and inundation of highways or outflanking of the bridges and at the community level to meet the specific needs of various users. This would require development of innovative risk communication (including management) tools;

6. There is a need to continue the development of monthly and seasonal forecasts to meet the need of agricultural planning and management. Necessary support may be arranged from the ongoing Regional Integrated Multi Hazard Early Warning System (RIEM) as facilitated by ADPC;

7. The above development would require ADPC to continue its program after June 2009 to enable incorporation of other important boundary discharge and simultaneously ground level basin information including infrastructure and hydraulic parameters of river systems for development of defendable long lead forecasts;

8. Flash flood areas require special attention to increase the lead time and necessary modelling capacity need to be developed and operationalised;

9. Capacity Building of institutional learning process through integration with DMIC could be an important step forward. The risk communication tools need to be oriented at all National-District- Upazilla- Union and Local community levels to offer a feedback of information flow from communities to forecast information providers and back;

10. The Seminar appreciates the generous support from USAID through CARE Bangladesh under its Shouhardo program as facilitated by ADPC and would expect continuation of the support for further development of the activities to reduce the risk of flood damage.

8 Closing Session

The closing was chaired by Mr Badrul Alam Tarafdar, Additional Secretary, Ministry of Water Resources. Mr.Emauddin Ahmad, Executive Director of IWM presented the seminar finding and recommendations in the closing session. Ms.Mandira Shreshta invited to speak on behalf of the participants during the session. The special guest of the session was Mr Faheem Y Khan, Team Leader, SHOUHARDO Programme, CARE Bangladesh, Dr. Bhichit Rattakul, Executive Director of ADPC and Mr H S Mozaddad Faruque, Director General, Bangladesh Water Development Board. The vote of thanks was presented by Mr. Sazedul Karim Chowdhury, Project Director, PFFWC, BWDB.

Guests for the Closing Session of the Seminar

8.1 Speech by the Special Guests

Mr Faheem Y Khan, Team Leader, SHOUHARDO Programme, CARE Bangladesh

Mr Faheem Y Khan, Team Leader, SHOUHARDO Programme, CARE Bangladesh in his inspiring speech introduced the major objectives of SHOUHARDO under which the CFAB initiative was

funded with support from USAID, and the difference the programme was already making to the livelihoods security of the project beneficiaries.

He expressed his confidence that such innovative approaches as CFAB would be required as pro-active adaptation approaches to an increasingly uncertain future. He congratulated the project partners and the international agencies for delivering on the objectives and expressed his hope that even the longer-term forecasts would be made possible shortly.

Dr. Bhichit Rattakul, Executive Director, ADPC

Mr. S.H. M. Fakhruddin read out the speech for Dr. Bhichit Rattakul, Executive Director, ADPC. He mentioned that ADPC is privileged to be associated with the Climate Forecast Applications in Bangladesh since the last ten years. It would have been impossible to deliver innovative products as in CFAB without the support from USAID, SHOUHARDO Program of CARE Bangladesh and partnership and collaboration of Georgia Tech, University of Colarado, FFWC, IWM, CEGIS, BMD and DAE. He hoped that this new technology will bring enormous benefit to the institutions and people of Bangladesh in reducing the flood disaster risk.

He also mentioned that enormous challenges remain in integrating new technologies into FFWC and BMD through continuous research into longer than 10 days forecast and ADPC facilitated Regional Early Warning System is committed to sustain this, and that FFWC, BMD are an integral part of this regional system.

Mr H S Mozaddad Faruque, Director General, Bangladesh Water Development Board

Mr H S Mozaddad Faruque, Director General, Bangladesh Water Development Board thanked all the participants and expressed his commitment to continuing to improve the forecast products. He thanked the project team including the national and international experts for their innovative forecasting under CFAB. The long lead forecasts are probabilistic in nature and require development and application of innovative risk communication tools in interpreting, translating science based information into user friendly languages for national institutions as well as community people. This requires a long term institutional capacity building process. He requested everybody to train up civil society, NGO and media to play a vital role in developing awareness amongst the people to understand this probability information.

He also mentioned to continue the CFAB initiatives for further refinement and implement the recommendations readout in the seminar.

8.2 Address by the Chairperson

Mr Badrul Alam Tarafdar, Additional Secretary, Ministry of Water Resources

Mr Badrul Alam Tarafdar, Additional Secretary, Ministry of Water Resources concluded the session by thanking all the participants and that the major objectives of the event were all achieved. He mentioned that there are many potential applications of long lead forecasts and its information, especially in Bangladesh. With advanced lead-time, we can perhaps save lives; we can salvage precious crops and food supplies. But the information must be made available to the people who can best use it, not only to the policy makers and planners but also to the farmers and local communities. Our Disaster Management policy is now being shifted from disaster preparedness to risk management where these early warning are important factor. In fact, Long Lead forecasts are one of the best tools to enhance our adaptation to climate change associated risks at present.

He mentioned that the recommendations of the seminar are very important and need to implement.

8.3 Vote of Thanks

Mr Sazedul Karim Chowdhury, Project Director, PFFWC, BWDB

Mr. Sazedul Karim thanked all the participants and organizer to organize such kind of event successfully. He thanks all the international experts to attend the seminar and contribute to enhance the flood forecasting and warning system. He mentioned the knowledge shared in the seminar is valuable to utilize the long lead flood forecasting system.

Annex 1a: Press Release- English

Ministry of Water Resources
Government of the People's Republic of Bangladesh

PRESS RELEASE

Long Lead Flood Forecast Technology for Disaster Management in Bangladesh

Dhaka, 3rd September, 2008 (MoWR). The Ministry of Water Resources is organizing a 2 day long international seminar to inform the people of Bangladesh and in particular, to the national and international scientific community about the technology achieved in increasing the lead time of flood forecasts from 1 to 10 days and its successful application at the community level. This is, indeed, a milestone event in the life of all Bangladeshis.

Bangladesh Water Development Board (BWDB) has so far achieved 72 hour lead time for the flood forecasting action. Over the years it was felt for a long lead-time so that flood induced losses could be mitigated effectively. BWDB has now developed this technology in its Flood Forecasting and Warning Center (FFWC). The technology is the out come of a research work conducted by Dr. Peter Webster in Georgia Institute of Technology, USA. The Asian Disaster Preparedness Center (ADPC) in partnership with FFWC of BWDB with National partners is testing and validating the technology in Bangladesh.

Initially in 2000-2004 the research works were conducted by ADPC with the support from USAID/OFDA. The result was observed significantly well. In 2006, the Government of Bangladesh through BWDB signed a MoU with ADPC to further continue this work to enhance lead time for flood forecasting and warning system. During 2006-2009, SHOUHARDO program of CARE Bangladesh through USAID supported a program to test and transfer this technology to Bangladesh Government. This also aimed to build capacity for sustainable end-to-end generation and application on long lead forecasts. The model covers three types of forecast schemes- short (1-10 days), medium (20-25 days) and long term (1-6 months). It is observed that the 1-10 days forecasts performed extremely well and two other schemes are still on experiment. This long lead forecast technology aimed to harness the latest advances in weather forecasts and climate prediction by using European Center for Medium-range Weather Forecasts (ECMWF) data, and to explore the possibilities for its application to various sectors, particularly in agriculture. It is to mention here that FFWC already has started flood forecasting for 2008 flood in 10 days ahead.

Five pilot areas namely (i) Rajpur union of Lalmonirhat district, (ii) Uria union of Gaibandha district, (iii) Kaijuri union of Sirajganj district, (iv) Bekra Atgram union of Tangail district and (v) Gazirtek union of Faridpur district have been selected for testing the application of newly introduced long lead flood forecast information at the community level. The pilot testing of forecast information process entailed capacity building of stakeholders involved in interpretation, translation and communication of probabilistic forecast information to enable them to transform science based information into impact outlooks with response options in actionable languages at the community level. The pilot testing of long lead forecasts revealed that through enhanced disaster preparedness significant socio-economic benefits could be accrued to communities at risk in saving lives and minimizing risks to livelihood systems such as early harvesting to avoid major crop damage, planning of transplanting of rice crops to avoid investment losses , take protection measures for saving assets and livestock, pre-harvesting of culture fisheries, plan for flood response activities at the local government level to support community responses and also take precautionary measures to protect infrastructures.

This experience of Bangladesh will be shared through this International Workshop. Experts from International agencies like, National Center for Atmospheric Research (NCAR), USA; International Center for Hazard and Risk Mitigation (ICHARM), Japan; International Center for Integrated Mountain Development (ICIMOD), Nepal; and Asian Disaster Preparedness Center (ADPC) will attend this seminar for 2 days and will discuss the issue in global aspect of flood forecasting technology, compare and contrast their own system and recommend for an efficient operational flood forecast technologies for disaster preparedness. Flood management experts from Bangladesh, Bhutan, China, India, Nepal, Pakistan, Philippines and Thailand will share the country experiences on flood forecasting and warning system. It is expected that the recommendations to be formulated from the seminar would enhance the capability for long-lead flood forecast in Bangladesh.

For more information please contact : Flood Forecasting and Warning Center (FFWC), Bangladesh Water Development Board (BWDB), WAPDA Building (8th Floor), Motijheel, Dhaka- 1000, Tel : 9553118, 9550755, E-mail : xenffwc@gmail.com.

Annex 1b: Press Release- Bangla

পানি সম্পদ মন্ত্রণালয়
গণপ্রজাতন্ত্রী বাংলাদেশ সরকার

প্রেস বিজ্ঞপ্তি

বাংলাদেশের দুর্যোগ ব্যবস্থাপনার জন্য দীর্ঘমেয়াদী বন্যা পূর্বাভাস প্রযুক্তি

ঢাকা ৩রা সেপ্টেম্বর, ২০০৮ (পানি সম্পদ মন্ত্রণালয়); বাংলাদেশ ১-১০ দিন পূর্বে বন্যা পূর্বাভাস প্রযুক্তির দক্ষতা অর্জনকল্পে এবং এর পরীক্ষামূলক সফল ব্যবহার সম্পর্কে দেশীয় ও আন্তর্জাতিক বিশেষজ্ঞগণকে তথ্য অবহিত করার লক্ষ্যে পানি সম্পদ মন্ত্রণালয় কর্তৃক ২ (দুই) দিনের একটি আন্তর্জাতিক সেমিনারের আয়োজন করা হয়েছে। এই সেমিনারটি প্রযুক্তির ক্ষেত্রে বাংলাদেশী জনগণের জন্য একটি মাইলফলক হবে বলে আশা করা যাচ্ছে।

বাংলাদেশ পানি উন্নয়ন বোর্ড বর্তমানে ৭২ ঘন্টার আগাম বন্যার পূর্বাভাস দিতে সক্ষম। বন্যার ক্ষয়ক্ষতি কমিয়ে আনার জন্য বিগত দিনগুলোতে একটি দীর্ঘ আগাম বন্যা পূর্বাভাসের প্রয়োজনীয়তা অনুভূত হচ্ছিল। আজকে বাংলাদেশ পানি উন্নয়ন বোর্ড এমন একটি দীর্ঘকালীন আগাম পূর্বাভাসের প্রযুক্তি আয়ত্ত্ব করছে। প্রযুক্তিটি আমেরিকার জর্জিয়া ইন্সটিটিউট অব টেকনোলজির বিজ্ঞানী ডঃ পিটার ওমেস্টারের গবেষণার ফসল। এশিয়ান ডিজাস্টার প্রিপার্ডনেস সেন্টার (ADPC) বাংলাদেশ পানি উন্নয়ন বোর্ডের বন্যা পূর্বাভাস ও সতর্কীকরণ কেন্দ্র এবং অন্যান্য জাতীয় সংস্থাসমূহ এই প্রযুক্তিটির বৈধ্যতা/ন্যায্যতা পরীক্ষা-নিরীক্ষা করে দেখছেন।

প্রাথমিকভাবে ADPC, USAID/OFDA এর সহযোগিতায় গবেষণা পরিচালিত হয়। এই সময়কালীন গবেষণার ফলাফল গ্রহণযোগ্য বলে বিবেচিত হয়। ফলশ্রুতিতে বাংলাদেশ সরকার ২০০৬ সালে পানি উন্নয়ন বোর্ডের মাধ্যমে ADPC-র সাথে একটি সমঝোতা স্মারক সই করে। বন্যা পূর্বাভাস ও সতর্কীকরণ কেন্দ্রে এই আধুনিক প্রযুক্তিকে আরও এগিয়ে নেয়া এবং তৃণমূল পর্যায়ে এর প্রয়োগই ছিল গবেষণার উদ্দেশ্য। ২০০৬ থেকে ২০০৯ ইংরেজি পর্যন্ত সময়ের মধ্যে বাংলাদেশ সরকারের নিকট এই প্রযুক্তিটি হস্তান্তরের জন্য কেয়ার বাংলাদেশের 'সৌহার্দ্য' কার্যক্রম এবং USAID সহযোগিতা প্রদান করে। একই সাথে দীর্ঘ মেয়াদী বন্যা পূর্বাভাসে এদেশের দক্ষতা বৃদ্ধি এবং কার্যপোযোগী করার জন্য কার্যক্রম গ্রহণ করা হয়। এ প্রযুক্তির উপর নির্ভর করে যে গাণিতিক মডেল তৈরি হয়েছে, তাতে তিন স্তরবিশিষ্ট (১-১০ দিন, ২০-২৫ দিন ও ১-৬ মাস) স্বল্প ও দীর্ঘ মেয়াদী পূর্বাভাসের গবেষণা করা সম্ভব। বর্তমানে শুধুমাত্র ১-১০ দিন পূর্বাভাস গ্রহণযোগ্য পর্যায়ে লক্ষ্য করা গেছে। বাকি দুই স্তরের জন্য আরও দীর্ঘ গবেষণার প্রয়োজন রয়েছে। ইউরোপের মধ্য মেয়াদী আবহাওয়া কেন্দ্রের (ECMWF) উপাত্ত ব্যবহারের মাধ্যমে একই সাথে অগ্রীম আবহাওয়া ও জলবায়ূর সম্ভাব্যতা যাচাই করা সম্ভব, যা বাংলাদেশের কৃষিকাজেও ব্যবহার করা যাবে। উল্লেখ্য যে, বন্যা পূর্বাভাস ও সতর্কীকরণ কেন্দ্র থেকে ২০০৮ সালে বন্যার পূর্বাভাস ১০ দিন পূর্ব থেকে প্রদান করা হচ্ছে।

৫টি পরীক্ষামূলক এলাকায় মাঠ পর্যায়ে এই বন্যা পূর্বাভাস প্রযুক্তি প্রয়োগ করা হয়। এই এলাকাগুলো হলো: ১. লালমনিরহাট জেলার রাজপুর ইউনিয়ন, ২. গাইবান্ধা জেলার ইউরিয়া ইউনিয়ন, ৩. সিরাজগঞ্জ জেলার কাইজুরী ইউনিয়ন, ৪. টাঙ্গাইল জেলার বেকরা আটগ্রাম ইউনিয়ন ও ৫. ফরিদপুর জেলার গাজীরটেক ইউনিয়ন। সম্ভাব্য পূর্বাভাস বার্তা পরীক্ষাকরণ প্রক্রিয়ায় তৃণমূল পর্যায়ে সুবিধাভোগী জনগোষ্ঠির দক্ষতা বৃদ্ধি, বৈজ্ঞানিক ব্যাখ্যার প্রতিক্রিয়া ইত্যাদি বিষয়গুলি বোধগম্য করাই এর উদ্দেশ্য। বন্যা পূর্বাভাস ফসলহানির পূর্বেই ফসল উত্তোলন, ধান রোপণ সম্পর্কে পরিকল্পনা প্রণয়ন, সম্পত্তি ও গবাদি পশু রক্ষা, মাছ চাষ বিষয়ে সর্তকীকরণ ব্যবস্থা. বন্যায় ক্ষতিগ্রস্ত হতে পারে এমন ভৌত অবকাঠামোর রক্ষাকল্পে সর্তকতামূলক ব্যবস্থা ইত্যাদি বিষয়ে সিদ্ধান্ত গ্রহণ করতে মাঠ পর্যায়ে সাহায্য করবে।

এই সকল প্রযুক্তিগত এবং মাঠ পর্যায়ের অভিজ্ঞতা এই আন্তর্জাতিক সেমিনারে তুলে ধরা হবে। বিভিন্ন আন্তর্জাতিক সংস্থা যেমন: National Center for Atmospheric Research (NCAR), USA, International Center for Hazard and Risk Mitigation (ICHARM), Japan; International Center for Integrated Mountain Development (ICIMOD), Nepal এবং Asian Disaster Prepardness Center (ADPC) এই দুই দিনের আন্তর্জাতিক সেমিনারে অংশ গ্রহণ করবেন এবং তাঁরা আন্তর্জাতিক দৃষ্টিকোণ থেকে বন্যা পূর্বাভাস প্রযুক্তি সম্পর্কে তাঁদের নিজস্ব প্রযুক্তির সাথে তুলনা ও পার্থক্য বিষয়ে আলোচনা এবং দূর্যোগ মোকাবেলাকল্পে বন্যা পূর্বাভাস প্রযুক্তির কার্যকর ব্যবহার সম্পর্কে মতামত প্রদান করবেন। এছাড়াও এ সেমিনারে বাংলাদেশ, ভুটান, চীন, ভারত, নেপাল, পাকিস্তান, ফিলিপাইন ও থাইল্যান্ডের বিশেষজ্ঞগণ বন্যা পূর্বাভাস ও সতর্কীকরণ বিষয়ে তাদের অভিজ্ঞতা বিনিময় করবেন। আশা করা যায় যে, সেমিনারে যে সকল সুপারিশমালা গ্রহণ করা হবে তা বাস্তবায়নে বাংলাদেশে দীর্ঘমেয়াদী বন্যা পূর্বাভাসের দক্ষতা বৃদ্ধি পাবে।

বিস্তারিত জানতে: বন্যা পূর্বাভাস ও সতর্কীকরণ কেন্দ্র, বাংলাদেশ পানি উন্নয়ন বোর্ড, ওয়াপদা বিল্ডিং (৮ম তলা)
মতিঝিল বা.এ., ঢাকা- ১০০০। ফোন: ৯৫৫৩১১৮, ৯৫৫০৭৫৫। ই-মেইল: xenffwc@gmail.com।

http://www.ffwc.gov.bd/

Annex 2: Agenda

INTERNATIONAL SEMINAR ON LONG LEAD FLOOD FORECAST TECHNOLOGY FOR DISASTER MANAGEMENT

3 – 4 September 2008, Dhaka
Seminar Information and Programme

Objectives

- Show case 1-10 days flood forecast products
- Share flood forecast applications
- Share lessons learned in flood forecast dissemination and response
- Launch 1-10 days flood forecast technology for disaster preparedness

Programme Day 1 — Wednesday, 3 September 2008

Session One: Opening Session

09.30 am	:	Registration
10.00 am	:	Recitation from the Holy Qur'ân
10.10 am	:	Welcome address by **Mr H S Mozaddad Faruque** Director General, Bangladesh Water Development Board (BWDB)
10.20 am	:	Keynote paper presentation on 'Forecast Experience of Flood 2007 and Launching of 1-10 Days Forecast for Disaster Preparedness' by **Mr Md Sazedul Karim Chowdhury**, Project Director, PFFC, BWDB
10.40 am	:	Speech by the Special Guest, **Mr Nick Southern** Country Director, CARE Bangladesh
10.50 am	:	Speech by the Special Guest, **Ms Denise Rollins** Mission Director, USAID Bangladesh
11.00 am		Speech by the Special Guest, **Mr James F Moriarty** Excellency, the US Ambassador to Bangladesh
11.10 am	:	Speech by the Chief Guest, **Dr C S Karim** Hon'ble Advisor Ministry of Agriculture and Ministry of Water Resources
11.30 am	:	Address by the Chairperson, **Mr Badrul Alam Tarafdar** Additional Secretary Ministry of Water Resources
11.40 am	:	Vote of Thanks by **Mr Saifuddin Ahmed** Joint Secretary Ministry of Water Resources
11.50 am	:	Press briefing

Session Two: Introduction and Overview

Chair: **Dr A R Subbiah**
Asian Disaster Preparedness Center (ADPC)

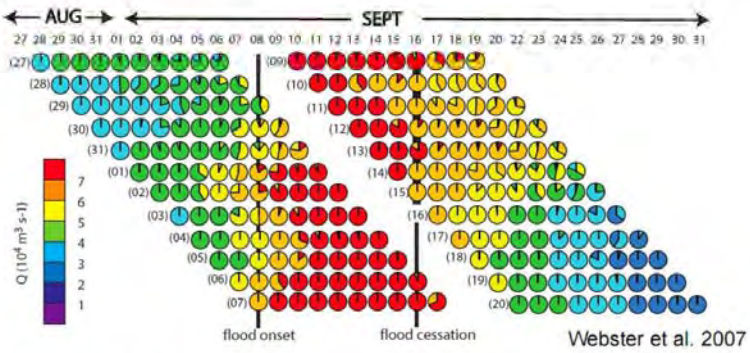
1200 – 1215	**Seminar Introduction and Overview** by Mr S H M Fakhruddin, ADPC
1215 – 1245	**Presentation:** ***Assessment/ Lesson Learned in Generation of Long Lead Flood Forecast Products*** by Dr Jayaraman KV Potty, ADPC, Mr Abu Saleh Khan, IWM and Mr Md Saiful Hossain, BWDB
1245 – 1300	**Presentation: Flood Forecasting Dissemination and Community Response** by Mr Ahmadul Hassan, CEGIS and Mr S H M Fakhruddin, ADPC
1300 – 1310	**Discussions and Closing Remarks by Chairperson**
1310 – 1400	***Lunch & Prayer***

Session Three: Sharing Experiences: Flood Forecasting Technology

Chair: **Mr H S Mozaddad Faruque**
Director General, Bangladesh Water Development Board

1400 – 1430	**Flash Flood Forecast Technology** Dr Jayaraman KV Potty, ADPC
1430 – 1500	**Water Hazard and Risk Management** Dr Kazu Fukami, ICHARM, Japan
1500 – 1530	**Rainfall Estimation in GBM** Ms Mandira Shrestha, ICIMOD
1530 – 1600	**Multi-Model Discharge Forecasting Technology** Dr Tom Hopson, NCAR
1600 – 1630	**Discussions and Recommendations**
1630 – 1700	**Tea Break & Prayer**
1700 – 1800	**Exhibition (IWM, CEGIS)**
1800	**Iftar followed by Dinner**

End of Day 1



Short-term forecasting, successful in providing high probabilities of exceedance of the danger level by the Brahmaputra 2007

Programme Day 2 **Thursday, 4 September 2008**

Session Four: Country Presentation: Flood Forecasting and Warning System

Chair: **Dr Kazu Fukami**
ICHARM, Japan

1000 – 1100	**Technical Session: Country Presentations on Flood Forecasting**
	- **Presentation by** Dr Karma Chhophel, Bhutan
	- **Presentation by** Dr Li Zhou, China
	- **Presentation by** Mr Suvanpimol Pongsthakorn, Thailand
	- **Presentation by** Shri S K Banerjee, India
1100 – 1115	**Tea Break**
1115 – 1145	- **Presentation by** Mr Dilip Gautam, Nepal
	- **Presentation by** Dr Oskar Cruz, The Philippines
	- **Presentation by** Mr Akhtar Mahmood, Pakistan
1145 – 1215	**Discussion and Recommendations**

Session Five: Closing Session

12.10 pm :	Recitation from the Holy Qur'ân
12.15 pm :	Presentation on seminar findings and recommendations by **Mr Emaduddin Ahmad** Executive Director Institute of Water Modelling, Bangladesh
12.25 pm :	Query and response
12.30 pm :	Speech by the Special Guest, **Mr Faheem Y Khan** Team Leader, SHOUHARDO Programme CARE Bangladesh
12.40 pm :	Speech by the Special Guest, **Mr H S Mozaddad Faruque** Director General Bangladesh Water Development Board
12.50 pm :	Speech by the Chief Guest, **Dr A M M Shawkat Ali** Hon'ble Advisor Ministry of Health and Family Welfare and Ministry of Food and Disaster Management
1.10 pm :	Address by the Chairperson, **Mr Badrul Alam Tarafdar** Additional Secretary Ministry of Water Resources
1.20 pm :	Vote of Thanks by **Mr Saifuddin Ahmed** Joint Secretary Ministry of Water Resources

Annex 3: List of Participants

Sl No.	Name of Participants	Name of Organization
1	Brigadier General Kazi Abidus Samad	Armed Forces Division
2	Lieutenant Colonel Md Main Ullah Chowdhury	Armed Forces Division
3	Lieutenant Commander A A Maksus	Armed Forces Division
4	Dr. Sultan Ahmed	BARC
5	Md. Mostafa Kamal	BDRCS
6	Nazmul Alam Khan	BDRCS
7	Joynal Abedin Molla	BHWDB
8	Sahidul Islam	BHWDB
9	Ahmed Arif Rashid	BMD
10	Arjumand Habib	BMD
11	Md. Abdul Mannan	BMD
12	Md. Sadekul Alam	BMD
13	Md. Shah Alam	BMD
14	Taslima Imam	BMD
15	Dr. A K M Saiful Islam	BUET
16	Dr. Mohammad Asad Hussain	BUET
17	Prof. Dr. Md. Monowar Hossain	BUET
18	A.H.M. Kawsar	BWDB
19	Abdul Bari	BWDB
20	Abu Taleb	BWDB
21	Ansar Ali Mia	BWDB
22	Azharul Islam	BWDB
23	Jasim Uddin Ahmed	BWDB
24	Kamrunnesa	BWDB
25	Lulu Maknoon Nahar	BWDB
26	M. A. Matin	BWDB
27	Mahfuzur Rahman	BWDB
28	Mamtaz Uddin	BWDB
29	Md Anowar Sadat	BWDB
30	Md. Abdul Hye	BWDB
31	Md. Abdus Sattar	BWDB
32	Md. Abul Bashar	BWDB
33	Md. Ariful Islam	BWDB
34	Md. Aminul Haque	CERP, BWDB
35	Md. Azizul Haque	BWDB
36	Md. Korban Ali	BWDB
37	Md. Kutub Al Hossain	BWDB
38	Md. Masum Goni	BWDB
39	Md. Mizanur Rahman	BWDB

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40	Md. Mohiuddin Ahmed	BWDB
41	Md. Nowshad Ali	BWDB
42	Md. Rezaul Haider	BWDB
43	Md. Saidur Rahman	BWDB
44	Md. Sarafat Hossain Khan	BWDB
45	Md. Shariful Islam	BWDB
46	Md. Saiful Hossain	BWDB
47	Md. Shorab Hossain	BWDB
48	Md. Zafor Iqbal	BWDB
49	Rafiqul Islam	BWDB
50	Rashidul Islam	BWDB
51	Rebeka Shaheen	BWDB
52	Zagirdar	BWDB
53	Golam Rabbani	Former Chairman, BWDB
54	Mukhlesuzzaman	Former DG, BWDB
55	H S M Faruque	DG, BWDB
56	Sharif Rafiqul Islam	Former DG, BWDB
57	Md. Saifuzzaman	BWDB
58	I. M. Reazul Hasan	BWDB
59	Belayet Hossain	BWDB
60	Md. Monuruzzaman	BWDB
61	H. Rabuean	BWDB
62	Md. Rezaul Karim	DD
63	Md. Abdur Rahman	BWDB
64	Md. Mahtab Hossain	BWDB
65	Md. Abul Kawsar	Planning, BWDB
66	Mr Dhali Abdul Qaium	BWDB
67	Md.Shawkat Ali	BWDB
68	Md. Kabibur Rahman	BWDB
69	AFM Mostafa Sarwar	BWDB
70	ADG, Training	BWDB
71	A B Siddique	CARE
72	Chitta Ranjan Biswas	CARE Bangladesh
73	Harun Ur Rashid	CARE Bangladesh
74	Md. Abdur Rahman	CARE Bangladesh
75	Md Sahidul Islam	CARE Bangladesh
76	Md. Showkat Osman	CARE Bangladesh
77	Ahmadul Hassan	CEGIS
78	Md. Maminul Haque Sarkar	CEGIS
79	Sultan Ahmed	CEGIS
80	Md. Shahidullah	CPP
81	Maksudur Rahman Gazi	DAE
82	Md. Abdul Kuddus	DAE

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85	Md. Abdul Motaleb	Department of Forest
86	Dr. Kazu Fukami	ICHARM, Japan
87	Mandira Srestha	ICIMOD, Nepal
88	Dr. Karma Chhophel	Ministry of Trade and Industry, Bhutan
89	Suvanpimol Pongsthakorn	Royal Irrigation Department, Thailand
90	Dilip Gautam	Nepal
91	Shri S K Banerjee	India
92	Priyo Joty Khisa	DMB
93	Probir Kumar Das	DMB
94	Md. Abu Sadeque	DMB
95	Dr. Mostafa Kamal Farooque	DOE
96	Md. Abul Kalam Azad	DOE
97	Md. Nur Alam	DOE
98	ATM Khaleduzzaman	Embassy of Kingdom of Netherlands
99	Md. Sazedul Karim Chowdhury	FFWC
100	A M Mustafa Sarwar	FFWC
101	Dr. Guna N. Paudyal	FFWS
102	Ahmed Obaydus Sani (Sana)	IFRC
103	Sazeda Sanzida Tauhid	IFRC
104	Abu Saleh Khan	IWM
105	Md. Sohel Masud	IWM
106	Mohammad Tohidul Islam	IWM
107	Sharifuzzaman Chowdhury	IWM
108	Tarun Kanti Mazumder	IWM
109	Saad Siddique, PEng	IWM
110	Md. Jahid Hossain Jahngir	JRC
111	Md. Mahmudur Rahman	JRC
112	Md. Moffazal Hossain	JRC
113	Md. Saifuddin	JRC
114	Md. Salim Bhuiyan	JRC
115	Tauhidul Anwar Khan	JRC
116	A F M Munibur Rahman	LGED
117	Md. Asraful haque	LGED
118	Md. Ataul Haque Molla	Ministry of Agriculture
119	A M Badrudduja	Ministry of Finance
120	Dr. Md. Shajahan Ali Khondoker	Ministry of Fisheries and Livestock (MoFL)
121	Abul Mansur Mohammad Sharif Uddin, Deputy Secretery	MoWR
122	Md Abdul Quariyum, Senior Assistance Secretary	MoWR

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124	Md. Moinul Islam Titas, Senior Assistant Chief	MoWR
125	Md. Selimul Haque, Senior Assistant Secretary	MoWR
126	Mohd. Enamul Haque, Assistance Chief, MOWR	MoWR
127	Mohammad Arifur Rahman. Assistance Chief	MoWR
128	Mizanur Rahman, Assistance Secretary	MoWR
129	Md. Abdul Mannan Jaluk, Joint Chief	MoWR
130	Ayesha Begum, Deputy Chief	MoWR
131	Md. Anwarul Haque, D, S, (Ad.)	MoWR
132	Md. Jahan Boksh	MoWR
133	Dr. Md. Akhtharuzzaman Hamid, Deputy Secretary	MoWR
134	Mirza Ahmed Baig, Information Officer	MoWR
135	Mahbubul Alam, System Analyst	MoWR
136	Jalal Uddin Md. Abdul Hye,PEng	WARPO
137	Abu Taher Amanullah	WARPO
138	Md. Alamgir	WARPO
139	Saiful Alam	WARPO
140	Dr Nilufar Islam	WARPO
141	Md. Zafor Ullah	Planning Commission
142	S. M. Zahir Khan	Planning Commission
143	Md.Nurul Islam	Roads & Highway
144	Bidhan Chandra Dhar	Roads & Highway
145	Md. Nazmul Huda Khan, ndc	SPARRSO
146	S. M. Humayun Kabir	SPARRSO
147	Cruz Oskard	Pacasa
148	Md. Moyeen Uddin	BTV
149	Begum Shahana Parvin	Radio Bangladesh
150	Dr. Sk. Tauhidul Islam	BRAC
151	Badrul Alam Tarafdar	MoWR
152	Saifuddin Ahmed	MoWR
153	Dilruba Yasmin	MoE
154	Ramraj Narasimhan	ADPC
155	Dr. Tom Hopson	NCAR, USA
156	Mr. Faheem Y Khan	CARE Bangladesh
157	Mr. Monzu Morshed	CARE Bangladesh
158	Mr. Suman Ahsanul Islam	CARE Bangladesh
159	Dr. A.R. Subbiah	ADPC

Sl No.	Name of Participants	Name of Organization
160	Mr. Atiq Kainan Ahmed	ADPC
161	Dr. Jayaraman KV Potty	ADPC
162	Mr. S.H.M. Fakhruddin	ADPC
163	Mr Md Rakib Hossain, Deputy. Secretary	MoWR