

Regional Integrated Multi-hazard Early Warning System





United Nations Economic and Social Commission for Asia and the Pacific

5th MONSOON FORUM



ACTIVITY REPORT

BANGLADESH

The 5th Monsoon Forum, in Bangladesh, was convened by the Bangladesh Meteorological Department (BMD), as part of the programme *"Reducing risks of tsunamis, storm surges, large waves, and other natural hazards in low-elevation coastal zones"* with support from the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) and the Regional Integrated Multi-Hazard Early Warning System (RIMES).

Section 1 INTRODUCTION



1.1 Background

The Monsoon Forum, a platform for enhanced application of forecast application, provides opportunity for regular dialogue between Bangladesh Meteorological Department (BMD), Flood Forecasting and Warning Center (FFWC), and their stakeholder institutions to promote a) enhanced understanding, by forecast user institutions, of forecast products including their limitations and uncertainties; and b) better appreciation, by BMD and FFWC, of users' information requirements. The process facilitates a cycle of refinement of forecast products to suit users' needs and development of more robust information sharing system, redounding to better application of forecasts for enhanced management of risks.

Built on the monsoon, a regular phenomena in the country, the 5th Monsoon Forum is organized by BMD with support from UNESCAP and RIMES through the project "Reducing risks of tsunamis, storm surges, large waves, and other natural hazards in low elevation coastal zones".

1.2 Objectives

The 5th Monsoon Forum, convened on 30 June 2013 at BMD Auditorium, Dhaka, Bangladesh, was with the following objectives:

- a) review the 2012 Southwest monsoon in terms of patterns of climate and performance of the seasonal climate and water level forecasts
- b) draw feedback from user institutions on the relevance/usability of the seasonal forecast for the 2012 Southwest monsoon season and recommendations for enhancement of forecast products
- c) present the seasonal forecast for the 2013 Southwest Monsoon season
- d) present sectoral potential impacts outlook and response options for possible application by stakeholders

1.3. Agenda

The 5thth Monsoon Forum agenda is presented below:

Agenda			
9.30-10.00	Arrival and registration of participants	BMD	
Session 1: Opening/Inaugural Session			
10.00-10.10	Recitation from Holy Quran		
10.10-10.20	Welcome Address	Mr. Md. Shah Alam Director, BMD	
10.20-10.30	Remarks	Mr. A. R. Subbiah Director, RIMES	
10.30-10.45	Introduction of Participants		
10.45-11.00	Group Photo and Coffee/Tea Break		
Session 2: Review of the 4 th Monsoon Forum and Verification of the 2012 Monsoon Season			
11.00 - 11.20	Summary of Recommendations during the 4 th	RIMES	

	Monsoon Forum		
11.20-11.40	Verification of Outlook for 2012 Monsoon Season	BMD	
11.40-12.00	Verification of Flood Forecast for the 2012 Monsoon Season	FFWC	
12.00-13.00	Discussion/Feedback from User Institutions on Relevance/Usability of Forecast for the 2012 Monsoon Season and Recommendations for Enhancement of Forecast Products	 Disaster Management Agriculture Fisheries Health Pilot site representatives 	
13.00-14.00	Lunch		
Session 3: Climate Outlook for the 2013 Monsoon Season			
14.00-14.30	Presentation of Climate Outlook for the 2013 Monsoon Season	BMD	
14.30-14.45	Discussion		
Session 4: Group Discussion: Sectoral Impacts Outlook and Response Options			
14.45-15.45	Group Discussion: Potential Impacts Outlook and Response Options	To be facilitated by BMD/RIMES	
16.00-16.15	Coffee/Tea Break		
15.45-16.15	Presentation of Sectoral Impacts Outlook and Response Options	Group Representatives	
16.15-16.30	Discussion		
Session 5: Way Forward and Closing Session			
16.30-16.40	Synthesis of Discussions and Recommendations	RIMES	
16.40-17.00	Closing Remarks	BMD	

1.4 Participants

The 5th Monsoon Forum was attended by 34 participants from government institutions, UN/international/regional development organizations, and research, business and media entities. These include:

Government Institutions

- Bangladesh Agricultural Research Council (BARC)
- Bangladesh Coast Guard
- Bangladesh Inland Water Transport Authority (BIWTA)
- Bangladesh Navy
- Bangladesh Rice Research Institute (BRRI)
- BMD
- Center for Environmental and Geographic Information Services (CEGIS)
- Comprehensive Disaster Management Programme (CDMP)
- Department of Disaster Management (DDM)
- Department of Livestock Service

- Directorate of General Health Services (DGHS)
- FFWC
- Survey of Bangladesh (SoB)
- Water Supply and Sewerage Authority (WASA)

UN/International/Regional Development Institutions/Research Organizations

- Bangladesh Center For Advanced Studies (BCAS)/ Asian Development Bank (ADB)
- CARE Bangladesh
- International Center for Diarrhoeal Disease Research, Bangladesh (ICDDRB)
- RIMES

Mass-Based Organization

• International Federation of Red Cross and Red Crescent Societies (IFRC)

<u>Media</u>

- Dhaka Tribune
- Ekattor Television
- SA TV

Pilot Site Representatives

- Galachipa, Patuakhali
- Jalia Palong, Cox Bazar

Section 2 OPENING SESSION

2.1 Welcome and Opening Remarks

Mr. Md. Shah Alam, BMD Director, welcomed the participants to the 5th Monsoon Forum. He then conveyed his thanks to RIMES for supporting the same. He acknowledged Mr. A.R. Subbiah, RIMES Director, for his presence in the 5th Monsoon Forum.

Mr. Alam explained that Bangladesh is a tropical monsoonal country and elaborated that climate in the country is influenced by the Southwest monsoon during summer and the Northeast monsoon in the winter. The Southwest monsoon, according to Mr. Alam, contributes about 70% of the country's total annual rainfall. He emphasized that while rain is a resource in Bangladesh, too much of it result to havoc, submerging at most two-thirds of the country and disrupting normal life in urban and rural areas. He continued that flood events result to enormous damages in different sectors (e.g. agriculture, fisheries, livestock); disruption of land, sea, and air transportation and communication; and aggravate erosions and landslides, among others. All these impacts, according to Mr. Alam, hamper the socio-economic development in Bangladesh.

Mr. Alam continued that in order to cope with adverse conditions and mitigate losses due to climate risks, BMD has been mandated to provide forecasts and warnings, and related information, to users/stakeholders in different levels. He explained that better application of forecasts could enhance the management of climate risks. According to Mr. Alam, in order for BMD to be up to date with the information requirements of and demands from user sectors, the Monsoon Forum is of upmost importance. He proceeded to underscore that RIMES has been playing a vital role in facilitating the Monsoon Forum, in Bangladesh, since 2009 and that the 5th Monsoon Forum was organized as part of the regular process.

Mr. Alam then thanked all of those who are working tirelessly behind the scene to ensure the success of the Monsoon Forum. He expressed his hope for a productive 5th Monsoon Forum.

2.2 Remarks

Mr. A.R. Subbiah, RIMES Director, delivered his remarks. He indicated that establishing the Monsoon Forum in RIMES Member States and Collaborating Countries is one of the institutions' key programs.

Mr. Subbiah explained that forecasts have associated uncertainties. And given the uncertainties, it is vital how institutions and communities are able to use the information in a risk management framework. He proceeded to provide example on using probabilistic forecast, noting the uncertainties, on specific activities.

Mr. Subbiah also emphasized the importance of influencing the policy process from the information producer-user relationship in the Monsoon Forum. He stressed that the strategy in the Monsoon Forum is a platform for seasonal process as every season poses impacts to different sectors (e.g. industry, agriculture, service sectors, etc.). According to Mr. Subbiah, there are weather sensitivities on human systems. He advocated that forecasts/climate information should be integrated into development planning.

In his remarks, Mr. Subbiah also underscored the need to invest in meteorological services for enhancement of BMD services.

2.3 Introduction of participants

BMD facilitated the introduction of participants.

2.4 Summary of Recommendations during the 4th Monsoon Forum

Ms. Policarpio presented the summary of discussions and recommendations during the 4th Monsoon Forum. She indicated that the session was intended for participants to recall the discussions, agreements, and recommendations during the 4th Monsoon Forum. She also encouraged participants to follow-up on such agreements/recommendations during the discussions subsequent to the different sessions.

She recalled that the 4th Monsoon Forum was conducted on 10-11 June 2012 at BMD Auditorium, Dhaka, Bangladesh. She elaborated the overarching goal of the Monsoon Forum which is the enhancement of the application of forecast information through the enhancement of users' understanding of forecast products and services, and appreciation of BMD and FFWC of users' requirements. According to Ms. Policarpio, the regular conduct of the Monsoon Forum facilitates a cyclical process of enhancement of forecast products and application of the same for better management of risks.

She underscored that BMD is taking the lead in convening the Monsoon Forum, with RIMES as a facilitating partner. Ms. Policarpio continued to explain that the 5th Monsoon Forum is undertaken in Bangladesh as part of the project "Reducing risks of tsunamis, storm surges, large waves and other natural hazards in low elevation coastal zones supported by UNESCAP and RIMES.

Ms. Policarpio then expounded on the Monsoon Forum process, indicated in Figure 1:



Figure 1. The Monsoon Forum is a cyclical process of generating and sharing forecast information by BMD and FFWC, developing and implementing impacts outlook and response options by sectoral stakeholder institutions, provision of feedback to BMD and FFWC on the usability/applicability of forecast information and enhancement of forecast products and services, based on recommendations.

Ms. Policarpio then discussed the expected outputs from the Monsoon Forum, viz.:

- preparedness for every season
- short- and medium-term recommendations on how to improve inter-agency coordination and collaboration towards greater uptake of climate information for various purposes (e.g. disaster risk reduction, planning, etc.)
- recommendations on how to better tailor climate information products to support decision-making
- long-term policy recommendations on how to better manage climate risks and adapt to climate change
- assessment of current and emerging needs in forecast generation and application

She then espoused on the recommendations during the 4th Monsoon Forum, as follows:

• Hydro-meteorological observations

- Densification/modernization of existing observation and monitoring stations. As a minimum requirement, each district should have a weather observation station. For urban areas, distribution could be zone-wise.
- More frequent observations of flood water level vis-à-vis peripheral river water level during heavy rainfall
- Provide radar observations at least 1-1.5 hours before impact of Nor'westers
- $\circ~$ Establish radar link with Cox's Bazar weather radar to improve weather forecasts

• Forecasts/warning generation

- Hourly rainfall forecasts
- 6-hour rainfall forecast, including rainfall intensity and duration, per zone, during the peak monsoon period
- At least 48 hours forecast lead time for extreme rainfall events
- Ensure regular forecast updates
- o Improved spatial and temporal resolutions of long-term forecasts
- Fortnightly updates of long-term forecasts
- Use of simple graphics and language, with detailed description, in communicating forecasts
- Introduce use of monsoon indicators
- Include hazard thresholds (correlation between rainfall and flooding) in communicating forecasts, particularly in urban areas
- Training/capacity building of forecasters
- Receive and evaluate user feedback

• Forecast/warning Dissemination

- Send forecast products to DAE, WASA, DGHS, and Fisheries Departments, including the National Crisis Management Center, and to regional/district offices for further dissemination to farmers, irrigation managers, and other users
- Provide BMD and FFWC contact details, including website address, to all government user departments.
- o Make BMD and FFWC websites more interactive for users
- Use mass-media as partner for disseminating key meteorological information
- Introduce a weather channel on television, to air during the monsoon, especially from July to September

- $\circ~$ Use electronic billboards, maximize use of print media in warning/forecast dissemination
- Forecast interpretation and translation
 - o Develop rainfall thresholds for urban areas
 - Training on forecast interpretation and translation
- Forecast producers-users interaction
 - Organize inter-department forum/workshop/training

• Warning Response/Preparedness

- BMD and FFWC to recommend required depth, width, and velocity of peripheral rivers
- $\circ~$ Earmark retention reservoirs, flood plains, and flood flow areas to keep them non-structured
- o Awareness building of stakeholders
- o Incorporate meteorological and seismological studies in national curriculum

• Research

 Detailed research on climate impacts on public health, in collaboration with the World Health Organization (WHO), International Center for Diarrheal Disease Research – Bangladesh (ICDDRB), etc.

Section 3 VERIFICATION OF THE 2012 MONSOON SEASON

3.1 Verification of the Seasonal Outlook for the 2012 Monsoon Season

This session was presented by Mr. Quamrul Hassan, Meteorologist, BMD. He discussed that most Global Producing Centers of Long Range Forecast (GPCs) predicted that the 2012 Southwest monsoon rainfall over Bangladesh was likely to be normal to below normal. Subsequently, he discussed that the World Meteorological Organization (WMO)'s South Asian Climate Outlook Forum (SASCOF) consensus for rainfall, over Bangladesh, was the likelihood of normal. He qualified that though the long-range forecast indicated normal to below normal rainfall, extreme events or depressions/storms could change the scenario.

Mr. Quamrul explained that the 2012 Southwest monsoon advanced to the Eastern and Central parts of Bangladesh by first week of June, then became weak and manifested in the rest of the country only by 16 June, a delay of seven (7) days from the normal monsoon onset. According to Mr. Quamrul, in the last week of June 2012, the Southwest monsoon became active, and heavy to very heavy rainfall occurred in the Northeastern and Southeastern parts of the country. He cited that on 26 June, 463 mm of rainfall was recorded in Chittagong. The rainfall event, according to Mr. Quamrul, resulted to land slides in the area. He cited that per Disaster Management Bureau data, there were 122 deaths during the said landslide events.

Mr. Quamrul continued that the 2012 Southwest monsoon withdrew from Bangladesh on 16 October. He the proceeded to discuss the observed monthly rainfall vis-à-vis normal rainfall, in different stations in the country, for the 2012 Monsoon Season, shown in Figure 2 to 14.



Figure 2. Observed rainfall, for June 2012, indicates that except in Chittagong and Sylhet, the rest of the country received below normal rainfall.

Figure 3. Deviation from normal rainfall, in different stations in the country, in June 2012.



Figure 4. Observed rainfall, for July 2012, indicating that except in Chittagong and Rangpur which received above normal rainfall, all other stations recorded below normal rainfall for the month.



Figure 6. Observed against normal rainfall, for different parts of the country, for August 2012. The figure indicates that all stations, except Sylhet, received below normal rainfall for the month.



Figure 8. Observed rainfall in different stations in the country, for September 2012, shows that Rangpur, Khulna, and Barisal received above normal rainfall while Dhaka, Chittagong, Sylhet and Rajshahi recorded below normal rainfall.



Figure 5. Recorded deviation from normal rainfall in different stations in the country, for July 2012.



Figure 7. Deviation from normal rainfall, in August 2012, in different stations in the country.



Figure 9. Deviation from normal rainfall for September 2012



Figure 10. A comparison of the observed rainfall for the 2012 monsoon season vis-à-vis long-term normal rainfall values indicating that except in Chittagong, all stations received below normal rainfall for the season.



Figure 11. Deviation from normal rainfall, in different stations, for the 2012 monsoon season.



Figure 12. Normal daily rainfall values against observed rainfall for the 2012 monsoon season.



Figure 13. Spatial distribution of rainfall, from July to September 2012, in Bangladesh.



Figure 14. Spatial distribution of rainfall during the 2012 monsoon season

Mr. Quamrul then summarized the behavior of the 2012 monsoon season, as follows:

- Rainfall onset was delayed, by 7 days, from normal onset date
- For the entire country, the 2012 monsoon rainfall was 3.9% below normal
- Monthly rainfall over the country was 3.7% above normal in June; 2.4% above normal in July; 15% below normal in August; and 10.4% below normal in September
- Except in Chittagong, all divisions received below normal rainfall during the 2012 monsoon season
- No depression formed in the Bay of Bengal during the 2012 monsoon season as against the normal of 4-6 depressions per season

3.2 Review of Water Level/Flood Forecasts

This presentation was delivered by Mr. Md Amirul Hossain, Executive Engineer, FFWC. The institution is under the umbrella of the Bangladesh Water Development Board (BWDB).

Mr. Hossain underscored that rivers in Bangladesh receive runoff from a catchment of about 1.72 million square kilometers, which is approximately 12 times as large as the country's land area. He proceeded to discuss that water-related hazards in the country include flood, storm surge, high tide (and associated saline intrusion), drainage congestion, erosion, drought, torrential rain, and landslide, among others.

He elaborated on the topography of Bangladesh, indicated in Figure 15. He provided the following information:

- About 16% of the area is below 1.5 m of mean sea level (MSL)
- About 50% of the country is within 6-7 m MSL
- 25-30% of the area is inundated during normal flood
- maximum of 68% of the total area is inundated during the 1998 flood

He elaborated that Bangladesh is a country of rivers, with six (6) hydrological regions and a total of 405 rivers, indicated in Figure 16.

Legend	
A Threndrind Baindary	
Roads	
Elevation in meter (PAU):	
	48-30m - 1 90-100m 39-60m - 1 18-100m 69-70m - 1 NaDah
(1997-1996) (1997-	89 - 90 m







Figure 16. Hydrological regions in Bangladesh, and associated rivers. With a total of 405 rivers crisscrossing the country, flood is a regular occurrence in most areas.

Mr. Hossain subsequently indicated areas prone to water-related hazards, in Figure 17.



Figure 17. Water-related hazards-prone areas in Bangladesh

Historical flood events, from 1954 to 2012, were discussed, as shown in Figure 18. He also discussed flood characteristics in Jhikorgacha, in 2011 and 2012, in Figure 19.



Figure 18. 58-year record indicates occurrence of floods, in Bangladesh, annually. 1988, 1998, and 2007 registered the most number of flood events in one year, with 61, 68, and 42 events, respectively.



Figure 19. Comparison between the flood, in Jhikorgacha, in 2011 and 2012. Flood, above danger level, persisted in the area for 89 days in 2011; and 49 days in 2012.

Mr. Hossain proceeded to discuss the disaster mitigation approaches, in the water sector, in Bangladesh. These include:

- Structural
 - o Flood control, drainage, and irrigation projects
 - Coastal embankment
 - Dredging to increase conveyance capacity
 - o Riverbank protection
 - Accelerated land reclamation
 - Surface water retention (including rainwater)
- Non structural
 - o Flood forecasting and warning services
 - Erosion prediction (planned)
 - Enhancement of capacity of stakeholders in forecast application

Mr. Hossain underscored the flood forecasting and warning activities of FFWC, indicated in Figure 20.



Figure 20. FFWC's process of data collection and generation and dissemination of flood forecast/warning to stakeholders,

FFWC products and services were then expounded, as follows:

- Daily rainfall situation and rainfall surface map
- Daily river situation
- Flood inundation map
- Daily situation summary and warning message
- Deterministic 24, 48 and 72 hours forecast
- Experimental 96 and 120 hours forecast
- Experimental 10 days forecast for select areas
- IVR voice message via mobile service (dial 10941)
- Reports, studies, evaluation

Mr. Hossain subsequently explained that long-range/seasonal water level/flood forecast is not yet available at FFWC. He proceeded to provide examples of FFWC's products and services, in Figure 21.



Figure 21. Experimental 5-day flood forecast issued by FFWC

According to Mr. Hossain, 5-day flood forecast is also available for the following stations:

- Ganges/Padma River at Harding and Bhagyakul stations
- Meghna River at Bhairab Bazar and Tongi stations

Mr. Hossain expounded that the dissemination of information, from FFWC, is done through email to all District Disaster Management Committees (DDMC), all concerned ministries, government and non-government organizations, among others. Email is likewise sent to Zonal Chief Engineers, Superintending Engineer, Executive Engineer, Sub-Divisional Engineer, and Water Management Units. He underscored that organizations not currently included in the FFWC contact list could request FFWC to receive regular flood bulletins.

Evaluation of 3-day flood forecasts, issued by FFWC, then followed. These are indicated in Figures 22 to 26.



Figure 22. Evaluation of FFWC's 3-day water level/flood forecast indicates 92% accuracy for forecast of 1 day lead time; 85% accuracy for forecast of 2 days lead time; and 79% accuracy for forecast of 3 days lead time.





Figure 23. Comparison of observed against forecast water level, from May to September 2012, at Bhairab Bazar Station, Meghna River, based on 1 day, 2 days, and 3 days lead time.



Figure 24. Observed against forecast water level, at Harding Bridge Station, Ganges River, for select months in 2012.





Figure 25. Comparison between observed against forecast water level, from May to September 2012, at Bhagyakul Station, Padma River.

Mr. Hossain elaborated that FFWC obtains water level data from 73 water level stations and 56 rainfall observation stations in four (4) basins, viz., Ganges, Brahmaputra, Meghna, and Southeastern Hill, for flood forecasting purpose.

At the end of the session, Mr. Hossain underscored the flood behavior in the Northern and Northeastern Regions in the country, in Figure 26, and provided the following conclusions relative to the 2012 monsoon season floods:

- 2012 flood was a normal one
- Flood duration
 - Short to moderate duration along the Brahmaputra-Jamuna Rivers (North)
 - Short to moderate duration in the Northeast
 - Moderate duration along the Padma River (central part)
 - Prolonged duration along Kobodak Rivers (Southwest part)
 - Flash floods in the North Eastern and South Eastern parts



Figure 26. Flood behavior in the Northern and Northeastern Regions, in Bangladesh, during the 2012 monsoon season

3.3 Feedback from stakeholder institutions on the 2012 monsoon season and usability of forecasts

3.3.1 DDM

According to DDM, after obtaining information from BMD and FFWC, they circulate the information, through the department's information dissemination system, throughout the country. It was indicated that if there are technical components in the information, DDM has no capacity to interpret or translate the same.

DDM subsequently raised the issue of the lack of location-specific forecast which impedes effective communication and application of information. DDM cited, as an example, forecast for storm surge indicating possible surges in meters for some districts. However, the entire district would not be affected by the storm surge, but only a few areas.

3.3.2 Agriculture Sector

According to the agriculture sector, there are 30 agro-ecological zones in the country and maps on these are available. It was advocated that forecasts be focused on these zones.

3.3.3 ICDDRB

According to Ms. Dilruba Begum, Research Officer, ICDDRB, there is correlation between temperature and mortality. She elaborated that ICDDRB is looking further into analysis on this correlation between climate parameters and health/diseases. Ms. Begum explained that ICDDRB has available data up to 2009.

3.3.4 Pilot site representatives

3.3.4.1 Jalia Palong Union Government

Mr. Anowar Chaiman, from the Union government of Jalia Palong, elaborated on response activities conducted in the area relative to Cyclone Mahasen. He related that from 11 May 2013, they were able to receive regular weather condition updates from CARE Office and from the Upazilla Disaster Management Committee. He continued that the response activities conducted in the Union were based on the forecast provided by BMD.

3.3.4.2 Charkajal Union Government

Mr. Saidur Rahman, Chairman of Charkajal, explained that the Union is in the Southmost part of the country, adjacent to the Bay of Bengal. According to him, the Union referred to its emergency response plan, after BMD circulated signal number 4. Mr. Rahman elaborated that the Union convened its Disaster Management Committee. Weather bulletins from BMD were received in advance through CARE and RIMES, via mobile phone. However, updating the information via mobile phone was problematic once the cyclone made its landfall as network connection was disrupted for about five (5) hours. Further communication regarding weather updates, was hence stalled.

Not receiving further information about the cyclone because of network issues, Mr. Rahman indicated that they were scared because of the vulnerability of the Union to the cyclone, with respect to location. He further discussed that in Charkajal, there were only nine (9) cyclone shelters which could accommodate a total of about 5000 to 5,300 people. As the Union's population is approximately 35,000, around 30,000 would not have shelters in case the cyclone hit the union.

The need for additional cyclone shelters was verbalized by Mr. Rahman, enjoining authorities present in the 5th Monsoon Forum to elevate the issue to proper government institutions and non-government/development organizations to provide assistance to the union in building the said shelters.

Section 4 SEASONAL CLIMATE OUTLOOK FOR THE 2013 SOUTHWEST MONSOON SEASON

4.1. Seasonal Climate Outlook for the 2013 Southwest Monsoon Season

Presented by BMD, this session commenced with the following information:

- The Southwest monsoon is one of the phenomena with the oldest weather observations. It is an economically important weather pattern and the most anticipated weather event. It is also a unique phenomenon.
- Bangladesh is an agricultural country; agriculture is the mainstay of the Bangladesh economy. Agriculture in Bangladesh is largely dependent on rainfall from the monsoon. Cropping patterns, in the country, are based on the monsoon behavior.
- About 71% of the annual rainfall in the country is obtained during the Southwest Monsoon season
- Bangladesh constituents, directly or indirectly, depends on the monsoon rainfall
- The economy of the country and livelihoods of the people are closely linked with monsoon rain
- The monsoon, while a resource, can also cause hazards (e.g. severe floods due to heavy rain, landslide, river erosion, etc.) which result to extensive damage to crops, livestock, properties, and loss of lives

BMD subsequently underscored the following:

- No climate model is being run at BMD as of the moment
- BMD obtains seasonal climate information from:
 - WMO Global Producing Centers (GPCs)
 - Canadian Meteorological Center (CMC)
 - Beijing Climate Center (BCC)
 - European Center for Medium Range Weather Forecasts (ECMWF)
 - Hydro-meteorological Center of Russia
 - Korean Meteorological Agency (KMA)
 - Tokyo Climate Center (TCC)
 - Meteo France
 - National Centers for Environmental Prediction (NCEP)
 - UK Met Office
 - Predictive Ocean Atmosphere Model for Australia (POAMA)
 - Centro de Previsao de Tempo e Estudos Climaticos (CEPTEC, Brazil)
 - South Asian Climate Outlook Forum (SASCOF)
 - International Research Institute for Climate and Society (IRI,USA)
 - o Indian Meteorological Department
 - Southern Oscillation Index (SOI), from Bureau of Australia (BOM)

He proceeded to discuss the outlook from different centers, in Figures 27 to 29.



Figure 27. First row, left: Rainfall outlook for July-August-September (JAS) over South Asia by BCC. The outlook shows likelihood of normal to above normal rainfall in most parts of Bangladesh, with a tendency for below normal rainfall on the Eastern tip of the country. First row, right: ECMWF outlook for JAS indicating the possibility of below normal rainfall in the country.

Second row, left: JAS rainfall outlook from Exeter showing probability of normal to below normal rainfall in Bangladesh for the season. Second row, right: Outlook generated by Melbourne GPC showing possibility of normal to below normal rainfall in the country.

Third row, left: Rainfall outlook generated by Montreal GPC for the 2013 monsoon season suggesting the likelihood of below normal rainfall in Bangladesh. Third row, right: Seoul GPC outlook for JAS showing the tendency for rainfall to be normal in most parts of the country.



Figure 28. First row, left: Seasonal outlook from Tokyo GPC showing the possibility of normal rainfall over most parts of Bangladesh for JAS. First row, right: JAS outlook generated by Washington GPC suggesting the likelihood of normal to below normal rainfall in the country.

Second row, left: Toulouse GPC outlook for JAS indicating the probability of normal rainfall over most parts of Bangladesh for the season. Second row, right: Probabilistic multi-model ensemble forecast illustrating the possibility of normal rainfall over Bangladesh for the season.

Third row, left: APEC Climate Center's precipitation outlook for JAS showing the likelihood of normal to above normal rainfall, in Bangladesh, for the season. Third row, right: SASCOF consensus outlook for the season indicating that normal rainfall is likely in Bangladesh.



Figure 29. Left: IRI multi-model probabilistic forecast for JAS 2013 illustrating the probability of normal rainfall over Bangladesh for the season. Right: Plume of different model outputs for probable ENSO behavior during the season.

After the discussion of seasonal outlook from different climate centers, for the 2013 Southwest monsoon season, BMD presented the following conclusions:

- Based on analysis of the ensemble products from GPCs, it is likely that rainfall over Bangladesh, for the season, would be normal, with the exception of the Southeastern part of the country which is likely to receive below normal rainfall, and the Western part where rainfall tends to be above normal
- SASCOF consensus outlook indicates that the large-scale summer monsoon rainfall for South Asia and the monsoon season in Bangladesh is likely to be within the normal range, with a slight tendency towards the higher side of the normal
- A depression could change the scenario
- There is difficulty in predicting extreme events which may occur during the season

Section 5 POTENTIAL IMPACTS OUTLOOK AND RESPONSE OPTIONS

5.1 Working Group Discussion

The group was divided into two (2) to discuss potential impacts outlook and response options, based on the monthly outlook released by BMD, in Figure 30. The groups discussed potential impacts outlook in the context of 1) disaster management, and 2) agriculture.



Figure 30. Monthly rainfall outlook, for 28 June to 27 July, issued by BMD

5.2 Presentation of Outputs

5.2.1 Disaster Management

The group indicated that more information was needed in order for them to develop potential impacts outlook and response options. The required information were:

- Upstream flow
- Distribution of rainfall

The group underscored that once the said information are known, those working in the disaster management field could inform respective ministries for possibility of flood or any emergency situation.

5.2.2 Agriculture

The group recapped that Dhaka, and other areas in the country, is likely to receive about normal rainfall. The group elaborated that about four (4) districts, including Chittagong and Sylhet, are likely to receive below normal rainfall, per BMD forecast.

According to the group, farmers could focus on T Aman as the main crop for July. The group indicated that monthly rainfall for the month might result to flash flood. It was further indicated that heavy-intensity rainfall/dry spell is not yet known.

If there is dry spell, the group indicated that irrigation could be provided for seedbeds. It was further elaborated that salinity is likely to increase in Kulna in the event of dry spell or less than normal rainfall. To address this potential issue, saline tolerant crop varieties could be used. Irrigation could also be utilized to reduce salinity.

In Chittagong, supplementary irrigation may be required. Those having tea gardens should address water stress.

Section 6 SYNTHESIS OF DISCUSSIONS AND RECOMMENDATIONS



6.1 Summary of Discussions

Key discussion points, during the 5th Monsoon Forum, are summarized hereunder:

Methodology used in forecasting

In response to query from the participants, BMD explained that seasonal forecasts are based on outputs from GPCs. These outputs, according to BMD, are generated using very complicated models. It was explained that based on analysis of the different model outputs, BMD prepares seasonal outlook for Bangladesh.

Forecast uncertainty

Per comments from stakeholders on the disparity between forecast and observed water level in some instances, FFWC explained that uncertainties are always associated to forecasts. According to FFWC, in forecasting, technical institutions always refer to events as having the possibility of occurring, reflecting uncertainties.

Technical details are not understood by media and other stakeholders Media representatives indicated that forecasts are ridden with technical details, and hence, there is difficulty in the understanding forecasts.

FFWC cited the 2012 flooding in Kulna and Satkira, with prior information from FFWC that flood is likely to happen with the anticipated two (2) months of rainfall. The information, however, was not used to the optimum for preparedness. According to FFWC, media and other stakeholders need to understand such information so that they can better disseminate and explain the information.

Forecast translation into impacts outlook and response options

- Stakeholders espoused that rainfall forecast does indicate potential implications. Stakeholders further discussed that flood forecast that indicates water level above the danger level is less meaningful because people in communities do not know what that means for them.
- According to DDM, it is working closely with BMD and FFWC to disseminate forecast/warning information throughout the country. DDM underscored however, that it has no capacity to interpret or translate technical information imbedded in the forecast.

* Dissemination of information up to the village level

According to CDMP, information dissemination in the village level is done through the Union Disaster Management Committee. The problem however, is that as of the moment, downscaled information at the village level, is not available.

It was also elaborated that CDMP and DDM are working on establishing a Memorandum of Understanding (MoU) with Bangladesh Ansar which has about 64 staff in each village that could assist CDMP/DDM in disseminating information to the local constituents.

CDMP emphasized that further work is required on simplifying technical components of forecast/waning information.

On the other hand, CARE indicated that as a pilot project, it is providing locationspecific forecast for select unions.

Further, Save the Children espoused that it could assist in dissemination of agrometeorological forecast through the Disaster Management Committees in select Unions. Save the Children explored the possibility of disseminating the information to a larger scope, through the District DMC.

In Unions relying on mobile phones for receipt of information/updates during inclement weather, problems of serious disruption of communication flow was discussed. In Charjakal, there was disruption of network services for about five (5) hours during Cycone Mahasen, hence forecast updates were not received during the disrupted period.

Establishment of thresholds for landslides

In response to queries from stakeholders, BMD explained that determination of soil characteristics is essential for predicting landslides in particular areas. As studies are not available on the same as of the moment, BMD could not establish the amount of rainfall that could trigger landslide in specific areas. BMD could only provide information on the anticipated rainfall in the country. It was also emphasized that heavy rainfall is not always the trigger of landslides. In some occasions, landslides could be triggered by light rainfall occurring over a number of days.

Investment required for enhancement of forecast/warning services

In order for BMD and FFWC to respond to the demands of stakeholders, investment is required for upgrading of facilities, computing systems, observation stations, etc.

Heavy rainfall and climate change

Based on inquiry from stakeholders on whether heavy rainfall associated with the current monsoon season is due to climate change, RIMES explained that according to the Intergovernmental Panel on Climate Change (IPCC), a single event could not be attributed to climate change. Hence, such events are part of climate variability.

✤ Spatial and temporal forecast resolution

WASA indicated that in April 2013, there were five (5) rainfall events and the institution had to struggle because there was no preparation for the drainage system. The rainfall was also not distributed evenly, hence there was water logging in some areas, but not in others. According to WASA, if rainfall is anticipated in a particular area at a specific time, advisories could be provided to stakeholders as to which roads, for example, could be used.

Stakeholders espoused that it is understood that as of the moment, it may not be possible to provide time-specific and location-specific forecast. However, it was indicated that hopefully, in the next three (3) years or so, forecast resolution could be enhanced.

RIMES explained that BMD, FFWC, RIMES, and other relevant institutions could work together to enhance forecast resolution. It was further explained that while technology is available to enhance forecasts, investment is required to do the same.

Development issues exacerbating flood problems in Dhaka

According to FFWC, flooding in Dhaka is not entirely due to excessive rainfall. Improper dumping of solid wastes exacerbates floods. FFWC underscored that unless civic attitude change for the better, the floods in Dhaka will worsen. FFWC cited a flood event in 2007 when even the Prime Minister's Office was inundated.

RIMES explained that due to climate variability, peaks/extreme events are experienced within a 20 to 30 year-period. According to RIMES, it is important to consider these peaks in designing development. RIMES espoused the need for analysis of long-term behavior of rainfall and variabilities thereof, and design development initiatives based on such analysis to avoid development initiatives to exacerbate hazard impacts.

Collaboration among institutions engaged in early warning/disaster risk reduction/disaster risk management

Due to some misunderstanding on the roles of various institutions in information dissemination in the community level, the need for collaboration/coordination of such institutions were underscored. The role of Cyclone Preparedness Program (CPP), as a key institution in forecast/warning dissemination in Bangladesh was also emphasized.

In consideration of addressing the gaps in the end-to-end early warning system, it was highlighted that different institutions, working in different levels, could firm up their collaboration to maximize the benefits to the system.

Correlation between climate and health

Further analysis on the correlation between climate and health could aid decisions. It was elaborated that disease surveillance outputs could assist decision-makers in anticipating possible diseases associated with projected climate and subsequently put in place mitigation measures to curb possible incidence of diseases.

Seamless integration of forecast

RIMES provided emphasis on the seamless integration of forecast products from BMD, for application. Due to the uncertainties, for example, associated with seasonal forecasts, it has to be supplemented with shorter-term forecasts. RIMES elaborated further that it is important that stakeholders understand how to use forecasts of different timescales.

6.2 Key Recommendations

Key recommendations, obtained from stakeholders during the 5th Monsoon Forum, are provided below:

* Enhanced spatial and temporal forecast resolution

Stakeholders recommended that forecasts resolution, both spatially and temporally, be improved. One of the impediments in applying forecasts, as expressed by stakeholders, is the lack of location-specific information, especially for rainfall. Likewise, room for improvements in temporal resolution was espoused. Stakeholders also suggested the possible inclusion of rainfall intensity, distribution, and upstream flow in forecasts.

Stakeholders in the agriculture sector further recommended that forecasts could also be anchored on agro-ecological zones.

***** Enhancement of the conduct of subsequent Monsoon Forums

- Inclusion, in the review of the previous season, analysis of DMH forecast vis-à-vis observed values to establish forecast accuracy and BMD's confidence level in its forecasts
- Inclusion of analysis of behavior of monsoon season for the past five (5) to 10 years so that stakeholders would get a better appreciation of inter- and intra-monsoonal variability
- User institutions should include, in their feedback on the experiences during the previous season, their observations on the manifestation of the previous monsoon season, how they were able to use the forecast, challenges in using the forecast, and other related points.
- Institutional landscaping to look into the differential information requirements of sectoral user institutions
- Conduct the Monsoon Forum twice a year; one should be conducted before the monsoon onset to provide appropriate lead time for user institutions to apply the forecast and another after the monsoon withdrawal to analyze the monsoon behavior, provide recommendations to improve forecast and deliver the seasonal forecast for the winter season.

* Mechanism for interpretation and translation of forecasts

Technical information abound forecast products. As of the moment, most institutions, media and local governments, do not have capacity in interpreting and translating forecast/warning information into operational language and advisories to facilitate enhanced application of forecasts among end-users. Hence, there is a need to establish a mechanism for forecast interpretation and translation so that the information that is disseminated to the union level could include possible impacts and responses relative to forecasted events.

Dissemination/communication of forecasts

Stakeholders suggested for BMD to send forecasts/warning to key focal persons in different institutions, through email or mobile phone, for easier and faster delivery of the information up to local level.

Undertaking of studies to establish correlation between climate and secondary hazards, and climate and societal concerns

- Collaboration of relevant institutions to undertake study on establishing locationspecific rainfall thresholds that could trigger landslides and other hazards
- $\circ\;$ Further analysis of correlation between climate parameters and health, to facilitate disease surveillance

***** Integration of climate information into development planning

• Development work, like drainage system and other infrastructures, could be designed/established based on analysis of climate characteristics in the past five (5) to 10 years, and anticipating future climate

* Densification of rainfall observation stations

- Stakeholders recommended that for optimum rainfall monitoring, one (1) rainfall observation station should be established every 30 square kilometers.
- Required investment for enhancement of weather/climate and water level forecast/warning services

- To enhance the generation and delivery of forecast/warning information, investment, from government and development institutions, is required for both BMD and FFWC in terms of upgrading of observation stations, acquisition of high-performance computing facility, development of forecasting models, etc.
- Development of forecasting model for Bangladesh was strongly advocated as according to BMD, outputs from models developed in other countries are not highly correlated to Bangladesh conditions
- While BMD strives to increase the quality of its forecast products and services, another constraint is the non-availability of high-performance computing facility that could support modeling work, etc.
- Enhancement of capacity of BMD and FFWC human resource to address differential information needs of sectoral stakeholders (e.g. livestock, health, agriculture, etc.)
- Capacity building of DMH human resource in seasonal climate forecasting

* Analysis of available models which could work well in Bangladesh

Stakeholders observed that different climate models provide different outputs. It was then recommended that hindcasting, vis-à-vis various model outputs and observed values, for the past 100 years or so, could be done to establish correlation of the said model outputs to Bangladesh climate. Models whose outputs are highly correlated with Bangladesh climate could then be used as primary reference in forecasting for the country.

The same methodology could be done by FFWC to see which flood forecasting models are more reliable.

***** Establishment of Divisional Weather Service Center for Application

It was recommended that Divisional Weather Service Centers for Application be established to better facilitate forecast application. These centers would focus on dissemination and translation of forecasts for application.

* Establishment of additional cyclone shelters in vulnerable areas in Bangladesh

It was recommended that relevant institutions represented during the 5th Monsoon Forum should advocate to higher government authorities, as well as international and regional development organizations, to provide assistance in establishing additional shelters in cyclone-prone unions, to include Charjakal, to ensure safety of the constituents.

Section 7 WAY FORWARD AND CLOSING SESSION

7.1 Synthesis

Ms. Policarpio provided a synthesis of discussions and recommendations.

7.2 Way Forward and Closing Remarks

7.2.1 Way Forward

Mr. Subbiah thanked BMD for taking the lead in convening the Monsoon Forum, and the participants for their active participation in the discussions. He then highlighted points to enhance the conduct of subsequent Monsoon Forums.

7.2.2 Vote of Thanks and Closing Remarks

Mr. Alam conveyed his appreciation of RIMES support to the Monsoon Forum and other activities relative to enhanced generation and application of forecasts. He also appreciated participants for their valuable inputs and expressed his hope that the information sharing in the 5th Monsoon Forum would be useful for the different sectors represented.



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