GEOSS in Asia and MAHASRI: particularly in Bangladesh

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Abstract: The northeast part of Bangladesh (Meghna basin) experienced flood especially flash flood almost each and every year. This basin is one of the important study areas in GEOSS/ MAHASRI (Bangladesh) to develop real time monitoring and flood forecasting systems. In this connection, 11 automatic rain-gauges have been installed and attempt has been taken to collect continuous radar data in the mentioned area. Collected data have been used in preparing conjugate map that will be used in MIKE 11 to prepare flood forecasting tools for the study region.

Background: Ten-year Implementation Plan for the Global Earth Observation System of Systems (GEOSS) [1] has been started in the year 2005 based on the agreement of the Third Earth Observation Summit, and new funding opportunities has emerged in Japan as well as in some other Asian countries. A new international program in Asia, tentatively named Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative (MAHASRI), focusing on establishing scientific basis of predicting hydro-climate monsoon system with intra-seasonal to seasonal time-scale, including developing warning systems for droughts and flood conditions of regional or river-basin scales has been proposed.

Introduction: Bangladesh is a very low-land and flat country situated between the foothills of the Himalayans to the North and the Bay of Bengal to the South (Fig. 1 a). The big landmass of India is located to the west of the country. It is at the eastern end of the great Indo-Gangetic plain and it is a land of rivers. There are 230 rivers in Bangladesh including 3 major named the Padma (Ganges in India), the Jamuna (Brahmaputra in India) and the Meghna and 57 transboundary. The rivers and their tributaries and distributaries drain a vast area of the sub-continent of India, the Himalayan Mountains and the Southern part of Tibetan Plateau (Fig. 1b). These unique geographic features produce distinct climate characteristics in this region. The country is beset by frequent natural disasters like floods, cyclones, storm surges, tidal bores and so on. Flood is a recurrent phenomenon occurring almost each and every year bringing colossal damages to crops, infrastructure and properties, creating constrain in the economy of the country [2].

About 93% of the catchments areas of the rivers are located outside the country (Fig. 1a). The flood water comes about 93% from the transboundary rivers. Water enters to Bangladesh through Ganges, Brahmaputra and Meghna are 380 BCM (billion cubic meter), 537 BCM and 195 BCM respectively. Now-a-days Bangladesh faces water scarcity in the dry season because of reduces of inflow from upstream catchments of GBM (Ganges-Brahmaputra-Meghna) basin. About one-fourth to one-third of the country is normally flooded each year during the monsoon period [2]. In Bangladesh, river floods, flash floods, rainfall floods, tidal floods and storm surge floods are usually occurred. The northeast part of the country is affected by flash flood and most of the flood water comes from the upper catchments. Flash flood forecasting is a difficult task without rainfall and water level data from the upper catchments. Therefore GEOSS/ MAHASRI (Bangladesh) is the platform for the regional cooperation.

Purposes: In the MAHASRI, there are four regional components which are a) Tropics (including India and the maritime continent), b) Tibet/Himalaya, c) East Asia and d) Northeast Asia. Among the numbers of countries from East and South Asia are involved, Bangladesh is one of them.

Bangladesh is one of the heavy rainfall countries in South Asia. So, intensive sounding and multiple Radar/Doppler radar observations in order to understand the structure of mesoscale convective systems (MCSs) are necessary. Additionally, there have been very less statistical studies on the MCSs in Bangladesh. Some statistical analyses of the structure, lifetime, echo top height and diurnal variation of the MCSs in Bangladesh by using the observation results are also expected through MAHASRI. As mentioned earlier, real time monitoring and flash flood forecasting in the northeast region of the country are also needed to be studied.
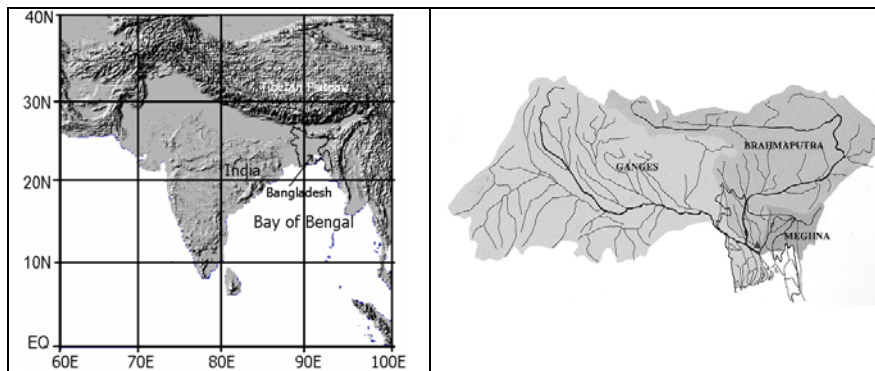

Fig. 1. a) Regional map showing Bangladesh and its surroundings, b) The Ganges, the Brahmaputra and the Meghna (GBM) basin.

Methodology: There are 4 radar systems existed in Bangladesh. At present, 2 radars are in functioning and one more radar (in the southern side of the country) is committed to replace with Doppler one very soon. Beside of this radar network, one more new Doppler radar at the Meghna Basin is proposed and expected to install by the year 2007. At present, there are 34 first class observatories and 10 PBO (Pilot Balloon Observatory) are existed in Bangladesh (Fig. 2). There are more 11 new first class observatory proposed to set in different locations throughout the country. Bangladesh Water Development Board (BWDB) and IWM (Institute of Water Management) are using surface water model for flood monitoring and forecasting. Currently, NOAA data are used as the input of the forecast model (MIKE 11). However, high temporal resolution data is needed as an input to improve the accuracy of the forecasting systems. The mentioned facilities are available and helpful for the implementation of GEOSS/ MAHASRI (Bangladesh) project. In MAHASRI, the Meghna Basin is one of the important study areas for flood monitoring and forecasting. Meghna Basin has typical characteristics of diurnal variation of rainfall: the peak time of rainfall in the land is early morning (at about 03:00-06:00 am) [3-5]. Also rainfall occurs in this region is from pre-monsoon to monsoon through post-monsoon periods. The outcome of Meghna Basin through GEOSS/ MAHASRI (Bangladesh) may be used as a model for other study region. It is planned to establish the densely distributed rainfall observation network in heavy rainfall area in the northeastern region of Bangladesh that can detect water cycle

and climatic changes associated around the Meghna river basin. Several rain-gauges concentrate in the relatively small target area in the southern foot hill of Meghalaya (Sylhet in Bangladesh). Simultaneously continuous radar observation will be conducted during rainy season by supplying the magnetron in the Bangladesh Meteorological Department (BMD). Both of the data from automatic rain-gauge network and radar system are compared and completed the real-time data acquisition system, which will contribute the quasi-real-time estimation of hourly rainfall distribution map with very fine spatial resolution (2.5km) in the Meghna river basin with the aid of the meso-scale numerical model (MM5). The high resolution data will be used as an input in MIKE 11 or MIKE 21 for forecasting purpose.

Fig. 2. Locations of first class observatory and PBO throughout Bangladesh.
The open circle represents the coverage of Dhaka radar system.

Results: Spatial distribution of historical rainfall collected by the Bangladesh Meteorological Department for 50 years from 1950 to 1999 is shown in Fig. 3. It is seen that heavy rainfall occurred in the southeast and northeast regions of the country whereas low rainfall occurred from the central to the western parts. However flash flood occurs from the rainfall inside the country and sometimes it occurs due to the water comes from the outside of the country. Therefore the information of the upper catchments i. e., from the GBM basin is much important to develop flood monitoring and forecasting systems in Bangladesh.

Fig. 3. Spatial distribution of rain-gauge rainfall over Bangladesh.

Figure 4 shows the annual rainfall anomaly from 1950 to 2001. The severe flood years are indicated by closed triangles. It is seen that in some years there are lack of rainfall inside the country but severe flood occurred. For examples in 1954 and 1955 there are deficient of rainfall inside the country but severe floods occurred in Bangladesh. The flood water comes from the upper catchments. So, regional cooperation is very much important for the monitoring and flood forecasting in Bangladesh.
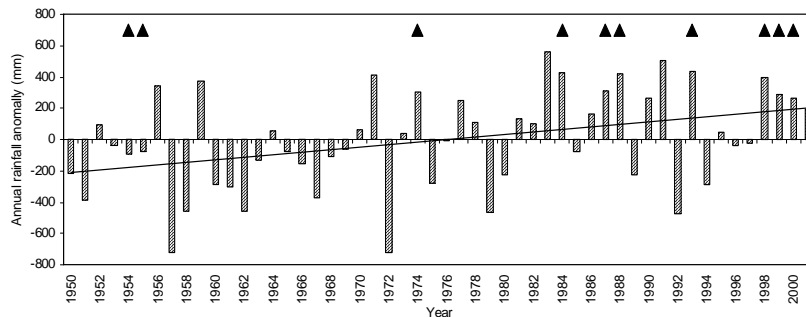

Fig. 4. Annual rainfall anomaly and flooded years in Bangladesh from 1950 to 2001.

Figure 5 shows the variation of decadal anomaly of flooded area in Bangladesh. It is clear that flood affected area increases in the last two decades especially from 1991-2000. In the last decade (1991-2000) the increase rate is maximum. This is the indication of increasing of flood hazards in this country. Therefore, improvement of flood forecasting system is essential.
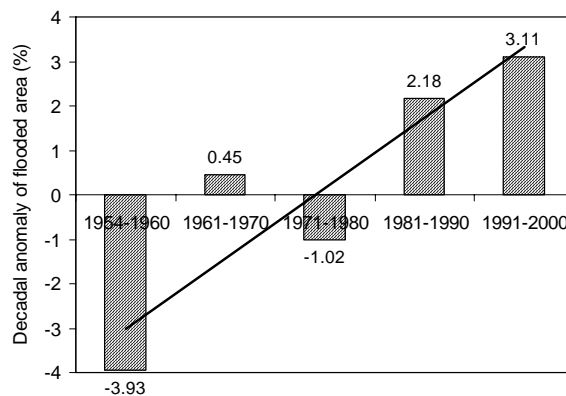

Fig. 5. Decadal anomaly of flooded area (%) in Bangladesh.

The flood situation in July 2004 over Bangladesh is simulated by MIKE 11 (Fig. 6). It is seen that in this year northeastern part of the country (Meghna basin) is flooded. Such type of flood situation is very common in this region. So, Meghna basin is one of the important areas in GEOSS/ MAHASRI (Bangladesh) project to monitor and develop forecasting tools. In this connection 12 automatic rain-gauges are installed in the Meghna basin those are collecting data from the beginning of March 2006. Attempt has also been taken to collect continuous radar data using Dhaka radar of BMD (coverage is shown in Fig. 2) during the monsoon period. The collected data through GEOSS/ MAHASRI (Bangladesh) project will be used to improve the flood forecasting systems of the country.

Concluding remarks: Analyzing flood affected area from 1950 to 2001 it is found that flooded area is increasing. Among the five decades, the maximum increase of flooded area occurred in the last one (1991-2000). The increase rate is about 3.31 (%). It is also found that flood occurred in Bangladesh despite of deficient of rainfall inside the country. For the better flood forecasting, high resolution data is necessary for model input. GEOSS/ MAHASRI (Bangladesh) can provide the required data from the country as well as from the upper catchments.
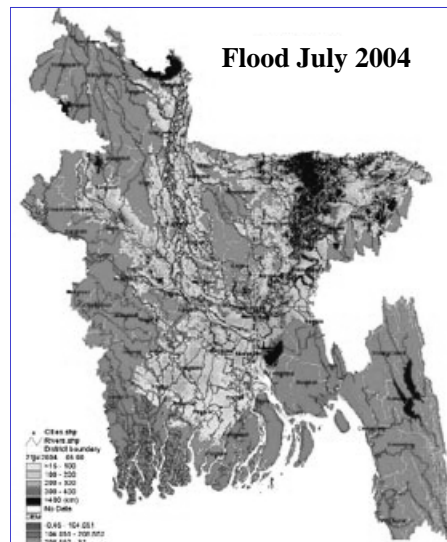
Fig. 6. Flood situation in July 2004 simulated by IWM using MIKE11.

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