Image 1: Flooding in Bangladesh.
Source: SHM Fakhruddin.

CASE STUDY 3:
Flood Early Warning in Bangladesh

The problem

In Bangladesh, flooding is common during the yearly monsoon rains and has significant impact on health, the economy and development. In 1998, more than two-thirds of the country was inundated with floodwater for three months, an estimated 1,000 people drowned and millions were left homeless[1].

The Ganges–Brahmaputra-Megna delta is the largest river delta in the world and makes up 80% of the area of Bangladesh. Most years, one-fifth to one-third of the country floods as the rivers overflow[2]. Not only are lives and homes destroyed but agricultural materials and livestock are also lost, resulting in huge economic losses (Image 1). Poorer farmers often purchase stocks on credit; loss of their crop or livestock in a flood can put the household into debt for many years.

Although flooding occurs most years in Bangladesh, it is irregularly timed and affects variable areas, making mitigation and preparedness difficult.

The science

Forecasts giving sufficient notice of likely floods would support timely evacuations, protection of assets as well as tactical decisions regarding the timing of planting and treating crops.

A project to develop and apply such monsoon flood forecasts was undertaken in 2000-09 within the Climate Forecast Applications Network (CFAN), a consortium of international and Bangladeshi organisations and institutes[3].

The resulting forecast system uses a variety of data including: weather forecast data from a European climate model; satellite and surface precipitation data from US satellites and local data collection; daily measures of the Ganges and Brahmaputra streamflow and meteorological data such as wind, humidity and temperature.

Proven statistical techniques then assess how well the precipitation forecasts compare with observed precipitation and make required corrections. Modelling of likely groundwater movement is then added. A probabilistic flood forecast is produced, giving the percentage likelihood of flooding (Figure 1)[4 – 6].

Testing over the next few years showed that the model's forecasts match well with the rainfall and river flow that is actually observed[7 – 8].

The application to policy and practice

Since 2004, the Bangladesh Flood Forecasting and Warning Centre (FFWC), with support from CFAN and later the Regional Integrated Multi-Hazard Early Warning System (RIMES), has been using its model to produce daily, 7-10-day flood forecasts. The forecasts are integrated into Bangladesh's disaster-management protocol by local experts.

In 2007, six flood-prone unions (equivalent to counties) were developed as pilot sites for community-level use of the forecasts (Figure 2). Community leaders were trained to receive forecasts by cell phone and to use local landmarks to express the likely level of flooding in terms that are clear and useful for villagers. Community leaders

1   Webster P. Improve weather forecasts for the developing world. Nature. 2013; 493:17-19.
2   Babel MS, Fakhruddin SHM, Kawasaki A. A Decision Support Framework for Flood Risk Assessment: An Application to the Brahmaputra River in Bangladesh. In: Chavoshian A, Takeuchi K (Eds.). Floods: From Risk to Opportunity. Oxford: IAHS Press, 2013.

3   Ibid.
4   Ibid.
5   Hopson TM, Webster PJ. A 1–10-day ensemble forecasting scheme for the major river basins of Bangladesh: Forecasting severe floods of 2003-07. Journal of Hydrometeorology. 2010; 11:618-641.
6   Webster PJ, Jian J, Hopson TM, Hoyos CD, Agudelo PA, Chang H-R, Curry JA, Grossman RL, Palmer TN, Subbiah AR. Extended-Range Probabilistic Forecasts of Ganges And Brahmaputra Floods in Bangladesh. Bulletin of the American Meteorological Society. 2010; 91(11):1493-1514.
7   Hopson TM, Webster PJ. A 1–10-day ensemble forecasting scheme for the major river basins of Bangladesh: Forecasting severe floods of 2003-07. Journal of Hydrometeorology. 2010; 11:618-641.
8   Webster PJ, Jian J, Hopson TM, Hoyos CD, Agudelo PA, Chang H-R, Curry JA, Grossman RL, Palmer TN, Subbiah AR. Extended-Range Probabilistic Forecasts of Ganges And Brahmaputra Floods in Bangladesh. Bulletin of the American Meteorological Society. 2010; 91(11):1493-1514.
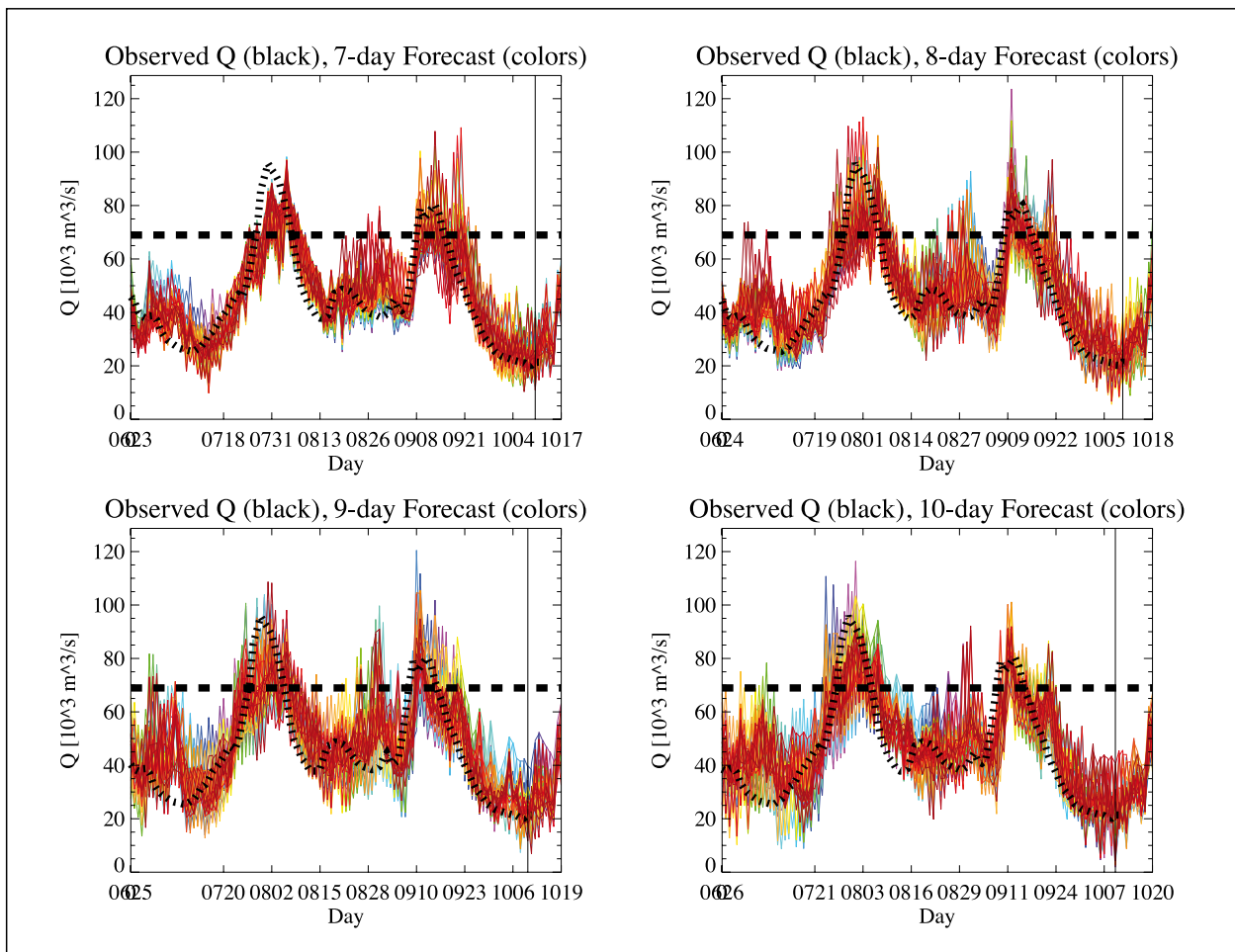
Figure 1: Graphs comparing the CFAN-RIMES model forecasts with observed river flow for the Brahmaputra in 2007. The wide, coloured band represents the output of each of the model's predictions. The thin dotted black line indicates the observed values of river discharge. The closeness of the coloured and black lines shows that the model is reliable in predicting flooding. *Source: RIMES* [9].

advise action such as telling farmers to harvest their crops or take cattle to safety, and telling households to store water, food and personal belongings ahead of a flood.

"We disseminate the forecast information and how to read the flag and flood pillar to understand the risk during the prayer time" reported one village Imam from Sirajgong District.

Did it make a difference?

Bangladesh experienced three major floods in 2007 and 2008. Each was forecast successfully 10 days in advance and action was taken. Communities moved to evacuation points in advance, fisheries were protected by nets, crops were harvested early ahead of impending floods, households were warned to store food and drink in advance, and mechanized boats were readied in case evacuation of farmers on river islands became necessary.

Speaking of the 2008 floods, the Imam from Sirajgong District tells: "In my field, T. Aman [a type of rice] was at seedling and transplanting stage, I used the flood forecast information for harvesting crops and making decisions for

seedling and transplantation of T. Aman...Also we saved household assets."

One analysis concluded that approximately US$40 was saved for every dollar invested in the regional forecasting and warning system [10]. The Asian Disaster Preparedness Center estimated that the average savings were US$400-500 per affected household [11]. Preventing the loss of one livestock animal, for instance, was shown to save a household around US$500: about one year's income in Bangladesh.

In flood-prone Bangladesh, flood forecast technology now plays a crucial role in saving lives and properties.

9 RIMES Flood Forecast database. Available at: http://www.rimes.int/wrh/flood-forecast [accessed 5 April 2013].

10 Webster PJ, Jian J, Hopson TM, Hoyos CD, Agudelo PA, Chang H-R, Curry JA, Grossman RL, Palmer TN, Subbiah AR. Extended-Range Probabilistic Forecasts of Ganges And Brahmaputra Floods in Bangladesh. Bulletin of the American Meteorological Society. 2010; 91(11):1493-1514.

11 Asian Disaster Preparedness Centre (ADPC). Flood Forecasts Application for Disaster Preparedness: Post Flood Forecasts Assessment 2008: community Response to CFAN Forecasts. ADPC, 2009.