Experimental short range water level and inundation forecast for the Brahmaputra river

Being the highest specific discharge river system in the world, the Brahmaputra river experiences number of long-duration flood waves during the monsoon season annually. Not only that, flash floods in its Himalayan tributaries cause damage to flood plain infrastructure. Floods not only carry high peak water discharge, but also bring a large amount of silt and debris. Therefore, the damage by a flood is driven by many factors like meteorological, hydrological, flood plain infrastructure and peoples' adaptation. Near real time flood prediction at basin scale with available weather forecast dataset is necessity for effective flood management. In the present study, WRF-Hydro model was setup over the Brahmaputra river basin for hourly discharge estimation at Guwahati gauge station. The WRF-Hydro model is capable of performing coupled and uncoupled simulations.

In this study we have used uncoupled WRF-Hydro simulations for discharge predictions. The model applies different terrestrial physics option such as overland flow, subsurface and channel flow for discharge predications. MOSDAC 3-day weather forecast was used as WRF-Hydro model forcing to generate hourly discharge time series. The simulated discharge data was converted into water level using rating curve information for the Guwahati gauge station. Hence, hourly water level time series was generated for better understating of hydrological stage of the river. To estimate inundation probability to the downstream of Guwahati gauge station an inundation library was created using historical flood events captured by SAR images. The flood inundation library was generated using Sentinal-1A SAR images from 2015 to 2018. We have used simulated and observed water level for the period of 2015-2018 to segregate the inundation extent w.r.t. river stage. Hence, for different river stage conditions probabilistic inundation maps were generated. These probabilistic inundation maps for the downstream of Guwahati were linked to discharge forecast. This hybrid approach of using discharge forecast and space based information were tested in recent flood event on 16-17 July 2019 in the Brahmaputra river.

WRF-Hydro model was used to predict 3-day water level and inundation probability during the monsoonal flood condition in the Brahmaputra river at Guwahati gauge station. The model predicted onset of flood event, where water level in the Brahmaputra river crossed the danger level at Guwahati on 13th July 2019 (Fig. 2). The highest water level and inundation was

predicted for 16-17th July 2019, which was also confirmed by the Central Water Commission (CWC) gauge station at Guwahati. The rainfall was accumulated for the period of 01-19th July 2019 over the Brahmaputra river basin. The Brahmaputra basin received high rainfall (>350 mm) scattered from upstream to downstream during this period (Fig. 1).

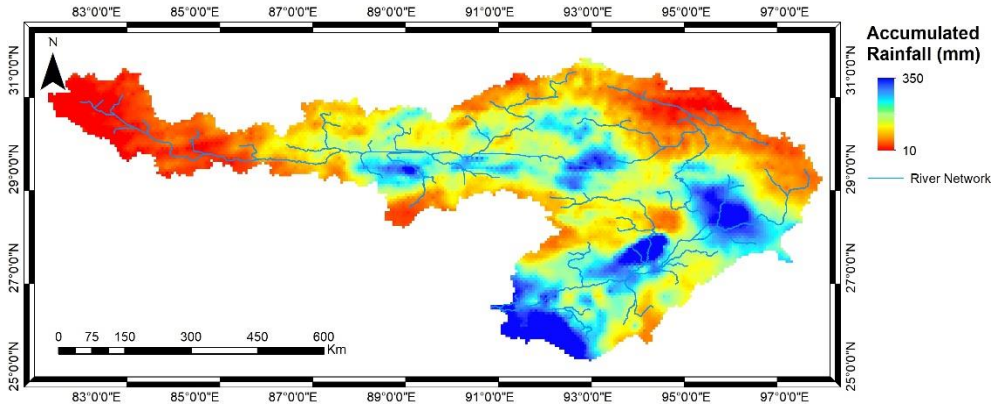

Fig. 1 Accumulated Rainfall for the period of 1-19 July 2019.

The WRF-Hydro discharge forecast on 11th July indicated the rising water level for the period of 11-13th July 2019 (Fig. 2). The Brahmaputra river is characterized with multiple flood events occurring during the monsoon season. The multiple peaks of water level were observed during this period prior to large flood event. The river witnessed the highest water level on 16-17 July 2019, which was also predicted by the model simulations during this period (Fig 3).

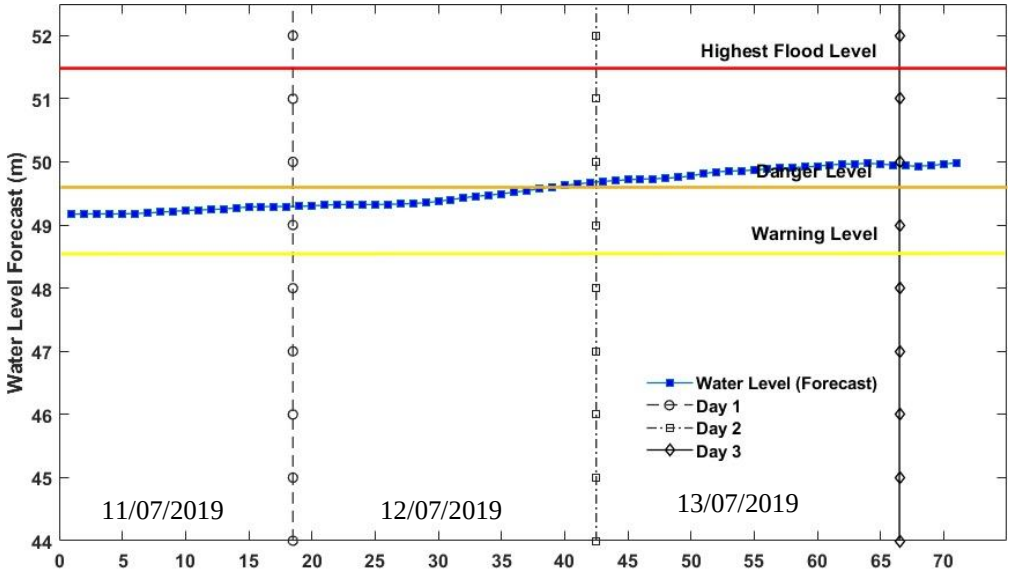

Fig. 2 Hourly water level forecast for Guwahati gauge station (11th July 2019 06:30 AM onwards).

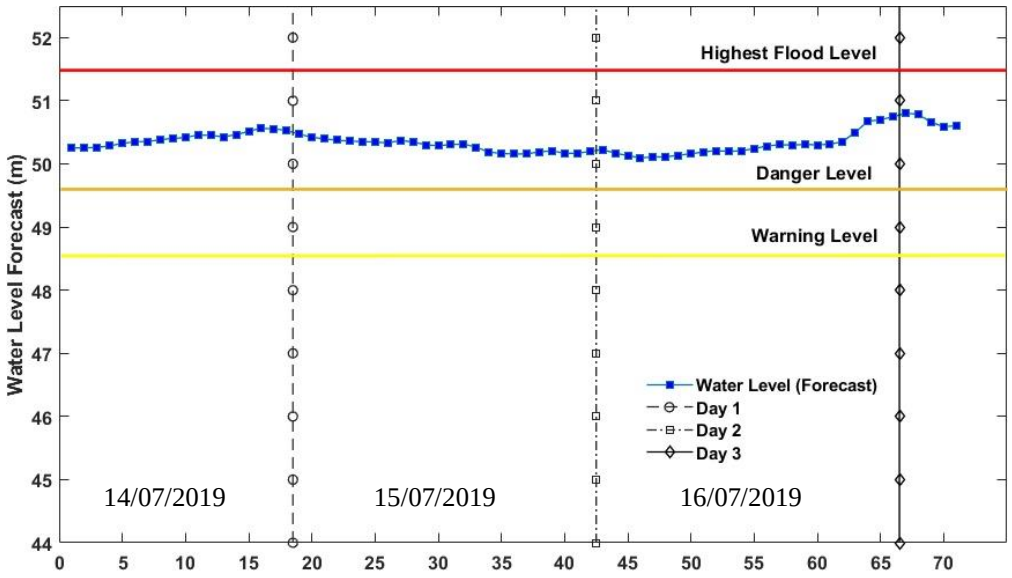

Fig. 3 Hourly water level forecast for Guwahati gauge station (14th July 2019 06:30 AM onwards).

A comparative analysis was carried out between predicted inundation probability and Sentinal-1A SAR derived inundation map (Fig. 4 and Fig. 5) for 16-17th July 2019. The spatial extent of inundation was well captured by model predicted inundation probability as compared to satellite derived inundation for the downstream flood-plains of the Brahmaputra river.

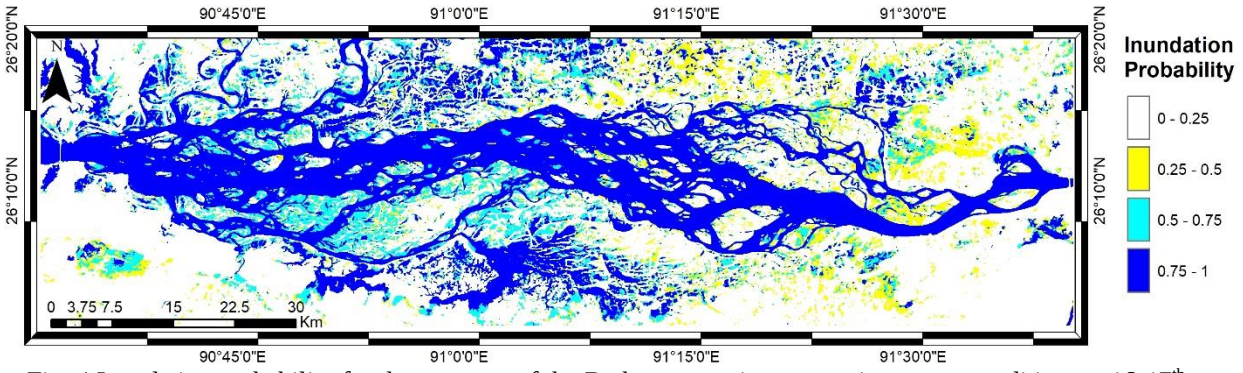

Fig. 4 Inundation probability for downstream of the Brahmaputra river w.r.t. river stage condition on 16-17th July at Guwahati gauge station.

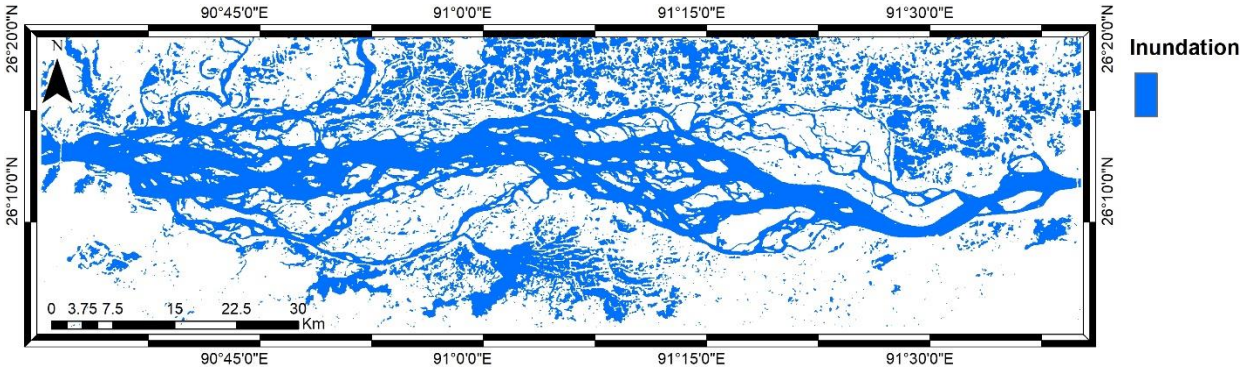

Fig. 5 Sentinal-1A SAR derived Inundation map (17-19 July 2019).