Geophysical Research Abstracts
Vol. 15, EGU2013-3698, 2013
EGU General Assembly 2013

Large-scale Flood Simulation with Rainfall-Runoff-Inundation Model in the Chao Phraya River Basin

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A large amount of rainfall during the 2011 monsoonal season caused an unprecedented flood disaster in the Chao Phraya River basin in Thailand. When a large-scale flood occurs, it is very important to take appropriate emergency measures by holistically understanding the characteristics of the flooding based on available information and by predicting its possible development.

This paper proposes quick response-type flood simulation that can be conducted during a severe flooding event. The hydrologic simulation model used in this study is designed to simulate river discharges and flood inundation simultaneously for an entire river basin with satellite based rainfall and topographic information. The model is based on two-dimensional diffusive wave equations for rainfall-runoff and inundation calculations. The model takes into account the effects of lateral subsurface flow and vertical infiltration flow since these two types of flow are also important processes.

This paper presents prediction results obtained in mid-October 2011, when the flooding in Thailand was approaching to its peak. Our scientific question is how well we can predict the possible development of a large-scale flooding event with limited information and how much we can improve the prediction with more local information. In comparison with a satellite based flood inundation map, the study found that the quick response-type simulation (Lv1) was capable of capturing the peak flood inundation extent reasonably as compared to the estimation based on satellite remote sensing. Our interpretation of the prediction was that the flooding might continue even until the end of November, which was also positively confirmed to some extent by the actual flooding status in late November. Nevertheless, the Lv1 simulation generally overestimated the peak water level.

To address this overestimation, the input data was updated with additional local information (Lv2). Consequently, the simulation accuracy improved in the lower basin by up to about 10 % for discharge and up to one meter for water level. However, the model predicted the recession of the flooding earlier than it actually did even with additional local information in Lv2.

By conducting the prediction and validation for the Thailand flooding, quite a few important aspects became clear concerning the current simulation model: what the current model can and cannot predict and what information we should prioritize as input over other information. In addition, the large scale flood inundation processes became also clear; for example, the location of flood vulnerable area and its relation to historical wetland regions, potential river discharge in case of no inundation. Conducting this kind of prediction, validation and diagnostic analysis repeatedly for large-scale flooding events can reduce prediction uncertainty and also help understand hydrologic processes at the large river basin scale.