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Incorporating flood magnitudes in remote sensing-based flood mapping techniques

Raja Bharath (1) and Amin Elshorbagy (1,2)

(1) Civil, Geological, and Environmental Engineering, University of Saskatchewan, Saskatoon, Canada (amin.elshorbagy@usask.ca), (2) Global Institute for Water Security, University of Saskatchewan, Saskatoon, Canada

Floodplain mapping is one of the key tasks in flood risk management. It typically involves developing hydrologic and hydraulic models that require detailed data and are computationally expensive. The task becomes challenging when mapping is required over large areas, and in data sparse locations. As an alternative, techniques that utilize only remote sensing and terrain data to identify flood-prone locations have been developed in the past. Such remote sensing-based maps have been found to be in good agreement with maps prepared using detailed hydraulic modeling. However, maps developed using this technique do not consider the flood event to identify flood-prone areas, i.e. these maps cannot be related to the flood of a particular magnitude or return period. In this study, we propose an approach to relate maps showing flood-prone locations prepared using digital elevation models (called flood-prone maps), to different magnitudes and return periods of floods. A flood-prone map developed for Canada in a previous study that classified the entire country into different flooding levels ranging from “severe” to “very low” based on the distance and elevation of a location from the nearest stream, is used for this purpose. Frequency analysis of streamflow is carried out at multiple stream gauges in Canada to determine flows associated with different return periods, and water surface elevations corresponding to these flows are determined using stage-discharge relationships at those locations. The ease in modifying the large-scale flood-prone map to reflect the flooding extents for different return periods is demonstrated. The flood-prone map is further validated by comparing with flooding extents obtained using hydraulic models at multiple locations across Canada. Uncertainties associated with determining flood magnitudes for different return periods and their effect on the large scale flood-prone map is also evaluated. Such comprehensive evaluation and validation of large-scale flood maps could increase their reliability and expand the scope of their applicability at locations where detailed hydraulic modelling is not possible.