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Flood risk assessment under uncertainty in the Canadian prairies

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To develop strategies for flood disaster mitigation, an assessment of flood risk is of high importance. Design of new structures or planning settlements along rivers require comprehensive flood risk assessment.. Stakeholders are well aware of various uncertainties surrounding flood estimation and mapping. This study proposes a probabilistic flood hazard mapping for well-informed decision making in the Canadian prairie floodplains. Flood risk is defined as the product of flood hazard and flood exposure wherein hazard is represented by the probability of a flood event, and exposure is represented by the value of the properties exposed to floods. The indicator of hazard is the inundation map that shows extent and depth of flooding corresponding to flood events of different return periods. On the other hand, landuse and population are indicators of flood exposure. This study uses a reach of the Qu'Appelle River in the province of Saskatchewan, the heart of the Canadian prairies, and two of its tributaries as a case study. A combined 1D/2D hydrodynamic model, using HEC-RAS, is setup for the reach to simulate water depth in the channel, as well as inundation extents and depth in the floodplain along the river reaches. Sensitivity analysis of the combined hydrodynamic model is carried out to identify the effect of various parameters (flow boundary conditions and roughness) on the hydrodynamic model outputs. Several model simulations are conducted based on perturbing parameters within expected ranges of uncertainties. Instead of defining the inundation extent by a single line, we provide probabilistic inundation extent and flooding depth at all points within the floodplain. Inundation probability, defined as the number of times a pixel in the floodplain is inundated divided by the total number of simulations, is estimated. This probabilistic flood hazard map (PFHM) helps visualize uncertainty in the boundary of flood extents instead of delineating the flooding extent as a single boundary. The sensitivity analysis proves to be crucial for screening the influential parameters and highlighting important uncertainties for flood-oriented decision making. The product of the PFHM and the exposure results in a probabilistic flood risk map (PFRM) with uncertainty bounds to arrive at more informed decision making.