



## Estimating flood exceedance probabilities for several levee breach scenarios for an urban riverine environment in Toronto, Canada

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Assessing flood risk requires the combination of flood hazard, exposure, and vulnerability. Hence, flood hazard is a key component of flood risk assessments. As flood propagation is impacted by hydraulic structures built along the river, flood defense such as levees have gained attention as they are rarely included in large scaled flood risk assessments. However, flood events such as hurricane Katrina showcased the impact that levee failure has on flow depth, velocity, and flood extent. Therefore, its consideration should be regularly implemented in flood risk assessments. However, with current flood risk assessment methods, considering different levee failure scenarios results in numerous flood scenarios, simulations, and hazard maps. The multiplication of simulations and maps increases the complexity of flood risk management. We propose to improve flood hazard assessments by considering a single probabilistic flood map accounting for several flood events and levee breaching scenarios. For flood events enabling the performance assessment of the levee (i.e. levee breaching), we assessed levee failure probabilities, associating each levee segment to a fragility curve. Then, we defined breaching and non-breaching scenarios and ran flood simulations using HEC-RAS and its integrated parametric levee breaching model. We propose a new method to compute flood scenario probabilities and flood exceedance probabilities. The cumulative flood exceedance probability provides a curve for every location of the flooded area. Using GIS, we applied this method to the entire flooded area, resulting in an interactive flood hazard map. An application to the Etobicoke Creek located in the Greater Toronto Area showed that this new approach provides an operational levee breaching flood hazard method that can be used in integrated flood risk assessments.