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(Article begins on next page)

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Methodology for the characterization of the risk of overtopping failure for a river levee

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This research presents the procedure and the application of risk and reliability analysis for levee overtopping. Hydrologic and hydraulic approaches are considered in the development of the risk models. Conventional procedures consider only one variable to account for the randomness of hydrologic forcing (i.e. peak discharge) but such approach might fail if other variables are also relevant. In the case of a river levee, the overtopping volume is a relevant variable that determines the probability of failure. In order to overcome this issue, the flood event may be described by a multivariate function accounting, for instance, for the relationship between flood peak and hydrograph volume. By a sensitivity analysis we demonstrate that there is a strong correlation between the shape of the hydrograph and overtopping volume which permits to create a shape hydrograph ranking. We also found that the duration of the hydrograph is less important for overtopping failure. A Monte Carlo experiment was conducted to generate an ensemble of hydrographs that maintain the observed statistical properties of the marginal distributions of hydrograph peaks, volumes and shape classification. This ensemble was applied to determine the Critical Overtopping Flood Hydrograph (COFH) for a levee, which is not a unique hydrograph, but rather a curve associated with a unique return period in the peak-volume space.