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Synthetic Hydrograph Generator for Reservoirs: Potential and Limitations

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The hydraulic design of dams and reservoirs still represents one of the most important tasks in hydraulic engineering, not least because of the high destruction potential in case of a structural dam failure.

The revised German dam standard DIN 19700 (2004) postulates for the design of reservoirs and flood control basins the use of hydrographs of extreme events with occurrence probabilities of up to T = 10.000 years. Hence, a large variety of different hydrographs has to be considered in the design since not only the peak discharge is of major interest but also the flood volume and the shape of the hydrograph.

A stochastic flood hydrograph generator was programmed and applied to the Obernau Reservoir (Germany) in order to simulate extreme flood events, based on the German guideline "Generation of Design Hydrographs following DIN 19700 in North Rhine-Westphalia", published by the Ministry of Environment of North Rhine-Westphalia (MUNLV). The program uses historical stream flow data of representing tributaries to the reservoir as the only input dataset. The shapes of recorded flood hydrographs can be described mathematically by combination of two analytic functions: The Kozeny Function for the rising part of the flood event and a parabolic function for the recession part. Overall, four parameters are used to describe the hydrograph: the time period of increasing discharge (t_A), the peak run-off (Q_S), the dimensionless shape parameters for the rising period (m_{an}) and for the recession period (m_{ab}).

Fitting distribution functions to all samples allows for generating any number of synthetic flood events by the random walk method, e.g. 10.000.

For simply shaped hydrographs, the program produces usable results. However, in case of shapes that are more complex, the method reaches its limits. Thus, multi-peak events cannot be illustrated adequately as well as slowly rising flood events. Another limitation of this method is the insufficiency to describe and simulate flood events where the peak flow remains almost constant for a specified time period. Especially those events can lead to severe loads for the spillway and the dam structure. The extension of the method by introducing a fifth parameter called peak flow duration (t_S) may resolve this limitation.

The results, which will be presented, will focus on the potential of this flood hydrograph simulation method and show limitations as well as approaches to improve the overall results.