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River flow simulations for the Tisza Basin in Hungary to estimate the uncertainty generated by superposition and coincidence of floods

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Several major floods passed River Tisza in Hungary in the course of history including the recent decade. Major floods in river system usually are the results of the superposition of several flood waves from upstream sections and also their coincidence with floods of the tributaries. This phenomenon was the basis for simulation exercises which were carried out for a limited number of scenarios generated from the combination of a few historical events. A more complex approach using a hybrid, seasonal, Markov chain-based model for daily streamflow generation were also used combined with a flood routing tool for the upper Tisza (Szilagyi et al 2006). Preliminary success brought the motivation for this study where probabilistic and hydrological methods were further combined in order to achieve an accurate model for possible flood scenarios in the future. The first step in model construction was to fit a non-homogenous Poisson process to the flood occurrences in the given area. Here the reversible jump Markov chain Monte Carlo technique, originating from Green (1995) was applied. These results were then used for simulating the number of floods in a given year. As the next step, the most important upstream stations of the river Tisza and its major tributaries were selected. The frequencies of floods (defined as an exceedance of the first level of flood preparedness) were then estimated for all subsets of these stations, which was used for the determination, which stations will be affected by a simulated flood. Here some smoothing was needed in order to avoid empty cells, which would result in zero probabilities of certain (definitely not impossible) scenarios. The univariate flood peaks were modelled by time-dependent Pareto distributions described earlier in Bozso et al (2005) were used for simulating from those sites, where a flood

wave occurred. Using a separate regression model for the dependence between the flood peak and its duration for each cross section, the corresponding flood length was chosen. Then a real flood, similar in height and duration was chosen randomly. Its transformation to the exact simulated height and length gave the two simulated observations per day, necessary for the river channel module i. e. the DLCM based flood routing system of the complicated river network of the Hungarian section of the Tisza Basin. The conditional independence of flood peaks was not rejected in most cases, so the above model for dependence looked as being realistic. The advantage of our proposed model is in its simplicity and that it results in realistic scenarios. It can be run quickly, so thousands of complete simulated floods can be got within a couple of hours. Results received produce possible future scenarios of flood events. This may help water managers to prepare for events that have not yet been observed in the past but none the less can be expected in the future. Detailed analysis of target station flood distributions supply also the measure of uncertainty resulting from the coincidence and superposition of flood waves.