



Investigation of coincidences of floods in the Upper Tisza region

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Major floods on the Upper Tisza down to the confluence of the main river with tributary Bodrog (Tokaj station) usually are the results of the superposition several flood waves from upstream sections and also the coincidence of the floods of the main river and tributaries. This phenomenon was investigated in case of recent major flood events. Simulation exercises 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 the DLCM based flood rooting system of the complicated river network. Diurnal increments of the rising limb of the main channel hydrograph were stochastically generated using fitted, seasonally varying distributions in combination of an additional noise term whose standard deviation depended linearly on the actual value of the generated increment. Increments of the ascension hydrograph values at the tributary sites were related by second-order polynomials to the main channel ones together with an additional noise term whose standard deviation depended non-linearly on the main channel's actual increment value. The recession flow rates of the tributaries as well as of the main channel were allowed to decay deterministically in a nonlinear way. The model-generated hydrographs were routed through the calibrated channel routing system. The model-generated daily values retain the short-term characteristics of the original measured time series (i.e. the general shape of the hydrograph) as well as the probability distributions and basic long-term statistics (mean, variance, autocorrelation structure, and zero-lag cross-correlations) of the measured values. Probability distributions of the annual maxima, means and minima of the measured daily values were also well replicated. Results received produce possible future

scenarios of flood events. This may help water managers to prepare for events that has not yet been observed in the past for which measurements are available but nonetheless can be expected in the future. While statistical analyses of e.g., annual maxima, may give information on the return period of floods with different magnitudes, they do not provide information on the possible time-sequence of the expected flood event. Such additional information encompasses duration of different water levels during flood, the speed at which stream levels may rise or the flood recedes, all of which potentially influencing how flood protection works ought to be planned and organized.