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Detection of changes in design discharges due to river engineering works by multilinear flow routing

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The attenuation of flood waves on alluvial reaches of rivers was often influenced by engineering works carried out mostly during the last century. This study presents a framework that can be used for estimation of changes in design floods in consequence of these works by detecting changes in the travel-time vs. peak discharge relationship and implementing them into a conceptual hydrologic flood routing model. The applicability of the methodology is demonstrated on two case studies on the Morava and Danube Rivers in Slovakia. First empirical data on the travel time of the flood peaks were collected from a set of flood waves from periods before and after the river engineering works had been completed. The patterns observed in the travel-time vs. peak-discharge relationships from both periods were analysed. Next, a multilinear conceptual flow routing model was fitted to larger floods from both periods. The discrete state space representation of the Kalinin-Miljukov model was used as the basis for a multilinear discrete cascade flood routing model of the river reaches studied. The time distribution scheme of the model inputs was employed in the setup of the model. The travel-time parameter of the multilinear model was allowed to vary with the input discharge into the river reach according to a piecewise linear relationship. The shape and parameters of that relationship were estimated by optimisation on the flood waves from the pre- and post-river training periods with the help of a genetic algorithm using the performance of the multilinear model as the optimization criterion. The resulting travel-time vs. discharge relationships were compared against those detected in the empirical data. It was shown that changes in the flood peak travel-times detected by the genetic optimisation of the performance of the multilinear model on a small number of floods exhibit the same tendencies as found in the empirical data. Since the changes detected in the attenuation of floods peaks were included in the parameterisation of the multilinear model, the changes in design floods had been assessed by frequency analysis of flood peaks gained by the simulation of the attenuation of a series of historical flood waves for pre- and post-river training conditions.