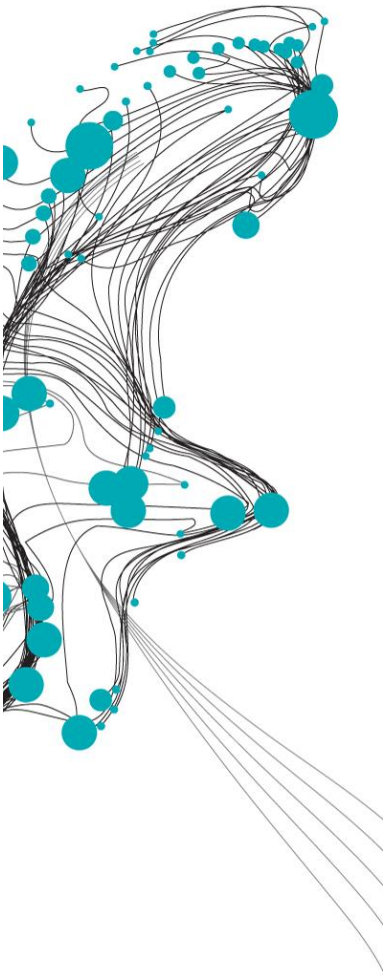
Performance of GRADE in simulating flood wave characteristics in the Rhine basin



Rhine discharges with a low occurrence probability are used as hydraulic boundary conditions, which are needed to carry out quality assessments of flood protection measures constructed in and around the Dutch Rhine. A physically based method, called Generator Rainfall and Discharge Extremes (GRADE), is used to determine these hydraulic boundary conditions. Within GRADE synthetic weather, generated by resampling of 56 years of historical precipitation and temperature data, is fed into the hydrological model HBV to simulate continuous daily discharge series. High discharges will be selected from the continuous discharge series, these flood waves will be used as the hydraulic boundary condition to assess the required stability of for example the dikes. Disapproved dike stretches should be reinforced, which might have large financial implications and can lead to public resistance. It is therefore important that the physical characteristics of flood waves simulated with GRADE are in accordance with reality. The objective of this research is to assess the performance of the hydrological model HBV and the combined performance of the weather generator (WG) with HBV, used within GRADE, in simulating the flood wave characteristics and the contributions to flood waves at Lobith of 7 major sub-basins in the Rhine basin.

Observed and HBV simulated flood waves from the period 1951-2006 have been compared to each other, to assess the skill of the HBV model in simulating the flood wave peak discharge, peak timing, volume, duration and number of flood waves per year. The performance of HBV, HBV-WG and WG in simulating the flood wave characteristics has been evaluated by comparing the statistics from observed and simulated flood wave characteristics from the period 1951-2006 and from 10.000 year HBV-WG simulated synthetic discharge series.

The performance of HBV and HBV-WG in simulating the discharge contributions of the 7 sub-basins to flood waves at Lobith is relatively good. The performance of HBV, HBV-WG and WG in simulating all flood wave characteristics of the Rhine basin at Lobith and Andernach is good. Also the characteristics of flood waves from the Main are simulated well. The simulated flood wave characteristics from the Moselle and Neckar differ slightly from the observed ones. For the Neckar this is mainly due to the HBV model. The errors detected in flood waves from the Moselle can be attributed to both the HBV model and WG. The flood wave characteristics from both Alpine region sub-basins are poorly simulated due to the HBV model. In figure 1 the cumulative distribution functions (CDFs) of the peak discharges at Lobith and Rekingen can be seen as an example. The peak discharges at Lobith are simulated well by both HBV and HBV-WG, this can be concluded because all CDFs are close to each other. The peak discharges at Rekingen are overestimated by HBV and HBV-WG due to HBV, because the CDFs of HBV and HBV-WG are comparable and both differ in a comparable manner from the CDF of the observations. The performance in simulating the other flood wave characteristics from the Alpine region basins is poor due to the HBV model. The simulation of the snow storage is probably the main reason for the detected differences.

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24 May 2016

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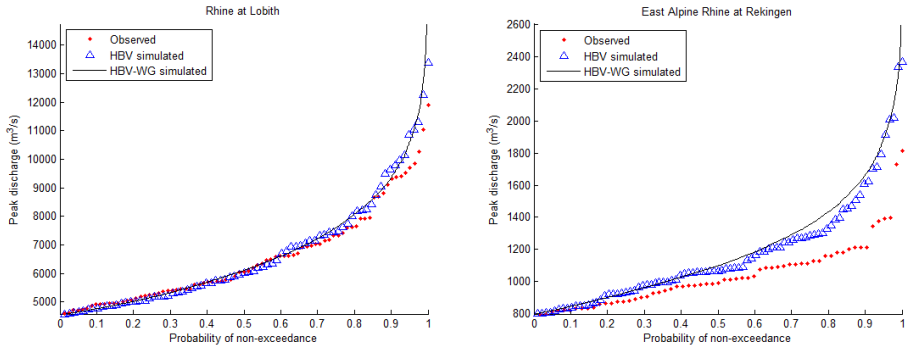

Figure 1 CDFs of the observed, HBV simulated and HBV-WG simulated peak discharges from the Rhine basin upstream of Lobith and from the East Alpine Rhine basin

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