ASSESSING THE INFLUENCES OF DIFFERENT HYDROLOGICAL MODELS ON FLOOD MAGNITUDES WITHIN A DISCHARGE GENERATOR

Until recently, the design discharges for the river Rhine were based on historical discharge data, with the return period of low probability high discharges based on a statistical analysis of a limited number of measured extreme events. Current research focuses on the use of resampled weather data, generated by a weather generator, as input for a more robust hydrological simulation. This approach is also followed in this study, where annual peak discharges for a 50.000-year synthetic data series simulated by two hydrological models are compared. This in order to assess whether the choice of a hydrological model within the discharge generator affects the annual maximum discharges of the Moselle basin, and therefore predicting different extreme discharges at large return periods.

First, a fifteen-year historical series was used to calibrate and validate the hydrological models HBV and GR4J using an automatic calibration method: SCEM-UA. This calibration method optimizes for objective function y, which combines the Nash-Sutcliffe coefficient (NS) and Relative Volume Error (RVE) metrics. It drives the model to simulate the high peaks, as well as the low flows correctly. The schematized Moselle area consists of 26 subcatchments, of which 21 contain a discharge station. The five remaining subcatchments use median parameter values as a substitute for calibration.

During calibration it was found that these five uncalibrated subcatchments influence optimal parameter sets of downstream catchments. These still perform well during validation, but the optimal parameter sets were found close to the limits of the parameter ranges. The model tends to compensate downstream by selecting extreme parameter values that are not realistic for the sub-catchment. Overall, GR4J outperformed HBV, particularly on the NS metric.

The last step in the process was combining the synthetic climate data with the previously calibrated hydrological models. The annual peaks of the 50.000 years series are visualized in flood frequency curves. The main finding here is that for areas with high quality data and no up-stream uncalibrated subcatchments, both GR4J and HBV roughly follow the same curve (figure 1). For catchments where data quality was an issue, with uncalibrated upstream subcatchments, results of GR4J and HBV deviated from each other significantly. Specifically, HBV shows more extreme discharges in the catchments downstream of uncalibrated areas (figure 2).

In conclusion, both GR4J and HBV perform well regarding observed climate data in the calibration and validation. When combined with the weather generator's synthetic series, the HBV model shows a sensitivity for uncalibrated upstream areas. The discharge generator could benefit from including multiple hydrological models, especially in areas with scarce data. Based on this research, HBV appears to be more susceptible for incomplete data than GR4J, but further research should confirm.

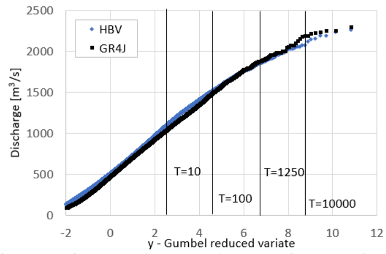

Figure 1: Flood frequency curve at Perl, an upstream sub-catchment without any upstream uncalibrated areas 50 000 years of synthetic annual discharge peaks plotted on a Gumbel scale with four return periods (T) visualized

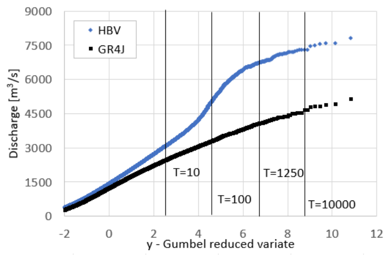

Figure 2: Flood frequency curve at Cochem, the last sub-catchment of the Moselle basin with a discharge station. 50 000 years of synthetic annual discharge peaks plotted on a Gumbel scale with four return periods (T) visualized

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