Comparison of different Approaches for Derived Flood Frequency Analysis

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Motivation & Aims

For the dimensioning of hydraulic structures design floods of different frequencies are necessary. In the case of missing long time series of observed discharge maxima for statistic analysis and for prediction of changes it is possible to determine design floods using rainfall runoff modelling.

Methods

Disaggregated daily precipitation data: For the disaggregation of the observed daily rainfall data a multiplicative random cascade model (Günther et al. 2001) is used.

Stochastic precipitation data: The stochastic precipitation data are generated using a two step space-time precipitation model (Haberlandt et al. 2008).

KOSTRA precipitation data: For single events KOSTRA design storms (KOSTRA 2005) were applied.

Hydrological modelling: For runoff simulation the conceptual semi-distributed model HEC-HMS (USACE 2006) is used.

Parameter estimation: Incorporating all available precipitation and discharge data 5 HEC-HMS parameter sets (a-e) were estimated through optimization (Fig. 1).

Determination of design floods: This is done using different precipitation data and parameter sets as specified in Fig. 2.

Results

Study region is a mesoscale subcatchment of the Bode river basin in Germany (Fig. 3).

Parameter estimation using the PEST algorithm yields good results for all parameter sets (Fig. 4 and Fig. 5).

The following diagrams show fitted general extreme value distributions using disaggregated (Fig. 6) and stochastic (Fig. 7) precipitation data as input. The used parameter sets are presented in Fig. 2. Parameter set b) (parameter estimation using observed precipitation data and observed discharge data) provides in both cases the widest spread. The spread can be clearly reduced if parameter sets d) and e) (parameter estimation using extreme values) were applied.

Fig. 8 shows the spread and the inherent uncertainty for a design flood with a recurrence interval of 50 years. The spread can be reduced considerably if synthtic precipitation data are not only used for determining design floods but also for the calibration of the hydrologic model.

Literature:


