Engineering Risk Analysis Group
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Master's Thesis – Environmental Engineering

Design Flood Estimation in Bavarian Alpine (and sub-Alpine) Catchments

Simon Mrowietz, April 2017

Background

Design flood estimation is crucial in disciplines of flood risk and flood management to protect endangered objects from extreme discharges. In ungauged catchments, which are often found in alpine regions, the design flood estimation is commonly done with the standard design storm (sDS) method that tends to underestimate the discharges due to its assumptions made. The probabilistic design storm (PDS) method overcomes these assumptions and hence generates more credible extreme discharges. This work applies the PDS method in Bavarian alpine catchments and derives recommendations for an improved design flood estimation.

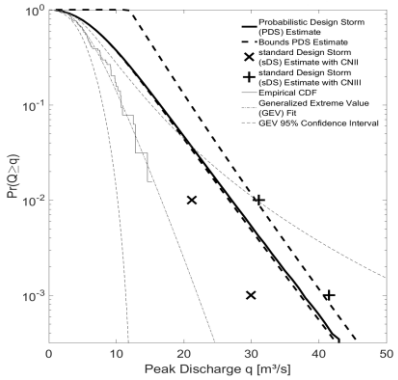

Figure 1: Annual Flood Exceedance Probabilities (y-axis) for peak discharges (x-axis) derived with PDS method (bold lines), with sDS method (crosses) and with extreme value analysis of measured discharges (dashed lines)

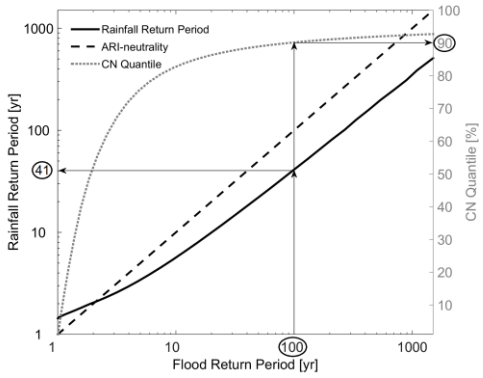

Figure 2: Design Chart to obtain input parameters (rainfall return period on y-axis 1 and CN quantile on y-axis 2) for sDS method in order to represent PDS results; arrows represent process to find parameters for design flood with 100yr return period

Methodology

The hydrological modelling is done with the event-based rainfall-runoff SCS/CN model utilizing two unit hydrographs. Parameters of 20 catchments are derived with GIS data and rainfall depth duration frequencies from the KOSTRA 2010 Atlas are applied. The first order reliability method (FORM) is used to account for the parameter uncertainties, found in the Curve Number (CN) and rainfall, and a series system is formulated to consider multiple rainfall durations.

Conclusion

The application of the PDS method yields in the following recommendations:

- Apply CN_{III} and $20\ yr$ – $75\ yr$ rainfall return period in the sDS method to obtain design floods with $100\ yr$ return periods;
- Apply rainfall reduction factor to obtain more realistic extreme discharges;
- Larger catchments result in larger rainfall return periods.

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