A CONTRIBUTION TO THE HARMONIZATION OF DETERMINISTIC AND STATISTICAL FLOOD ESTIMATION METHODS

(HOWATI-HOCHWASSERTIROL)

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INTRODUCTION

Extreme flood estimation plays a major role in water resource systems as extreme events can provide an immediate hazard to the life and property of people as well as to water resource structures. For the design of flood control measures and the assessment of risk areas accurate flood estimates are needed. Still, currently applied statistical and deterministic approaches for flood peak estimation often yield very inconsistent results that may even differ up to a magnitude of three in the worst cases. This project focused on explaining the reasons for the discrepancies in the currently applied approaches in order to contribute towards a harmonization in the estimation of extreme floods. To this purpose, a detailed study in the region of Tyrol (Austria) has been performed.

METHODOLOGY

Within this project flood estimates determined by different statistical and deterministic methods (see Fig. 1) were compared and evaluated for ten alpine pilot catchments (4-100km^2) in Tyrol. The study included two modelling parts, a deterministic approach with an event based rainfall runoff and a probabilistic approach including Monte Carlo Simulations. Flood estimates from flood frequency statistic were already available for the whole region from the HORA project (Merz et al. 2008). Also, a detailed hydrogeologic assessment including field trips was performed for each pilot catchment as input information for the models.

In the first part of the project the deterministic design storm approach was applied using the events based ZEMOKOST model (Kohl 2005), which was especially developed for ungauged alpine catchments. This method allows for a detailed description of the catchment characteristics. Model parameters were chosen based on specific guide (Markart et al. 2004) that was developed in a series of irrigation experiments. All available information on the catchments such as hydrogeologic information, orthophotos, landuse maps, etc. were included in the model and the parameters verified in field trips. However, a deficit of the method is, as in other event based models, that the return period of the flood estimates is determined by the return period of the respective design storm. This is an arguable assumption.

In a second step of the project a probabilistic approach was applied. The chosen method allows for the inclusion of catchment characteristics and also for the indication of the return period of the flood estimate. To this purpose a distributed continuous rainfall runoff model (Blöschl, 2008) was used and calibrated with all available catchment information. For the validation, observed discharge data were

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available for each catchment. Then, long term precipitation series (10.000 years) were generated by means of a stochastic precipitation model (Sivapalan et al., 2005) and applied to run Monte Carlo simulations with the calibrated rainfall runoff model over 10.000 years. The simulation results, runoff series over 10.000 years, were used to estimate extreme floods with a certain return period. Figure 1 summarizes the different methods applied. The different flood estimates were compared for the same return period taking into account model assumptions.

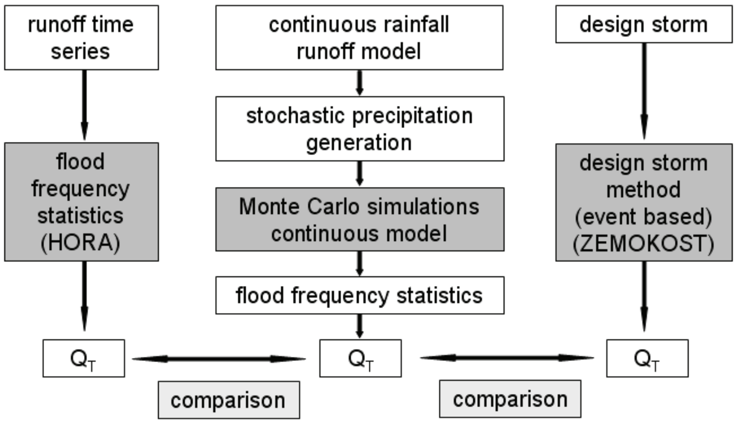

Fig. 1 Different methods for the estimation for extreme floods

RESULTS

The outcome of the project showed weaknesses in both, deterministic and statistical approaches. The analysis of the results of the deterministic approach demonstrated that usually very high design storm values are used for the design storm method in Austria. A recommendation for a more reasonable rainfall input based on the available Austrian data is given. Flood frequency statistics on the other hand might not correctly extrapolate to events with high return periods in certain cases. Monte Carlo simulations showed that threshold processes can cause a step change in the flood frequency distribution in catchments with high storage capacities. In this case the estimated extreme flood is considerably higher than the one estimated by flood frequency statistics. Consequently catchment characteristics should be taken into account when valuating statistically estimated extreme floods. Hydrogeologic information was proven to be especially valuable for assessing the catchments storage capacities.

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