

Statistical Modelling of Annual Maxima in Hydrology

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Abstract:

In this presentation conditional modelling of annual maxima for predicting flood water is considered. The annual maximum investigated here is the maximal discharge of a river in a year. Annual maxima were observed on 102 gauging stations in Styria (Austria) for a time period up to 52 years. In addition the properties of the corresponding catchments of the rivers were recorded. The aim is to predict the expected flood water of catchments, where no data about the discharge but data about the properties are available. Therefore a model for the annual maxima using the properties of the catchment as explanatory variables was fitted. Based on this model the expected flood water can be predicted.

Theoretical considerations about annual maxima imply, that they follow a generalized extreme value distribution. Empirical analysis suggested, that here the maxima are Gumbel distributed. The Gumbel distribution is described by a location and a scale parameter. The quantiles of the Gumbel distribution are used to predict expected flood water. Thus for predicting flood water the parameters of the Gumbel distribution have to be estimated. For this reason the annual maxima were modelled within the framework of generalized linear models. Plotting the empirical mean and variance of the annual maxima reveals a quadratic mean-variance relationship. Therefore the quasi likelihood approach was used with a log-link and quadratic variance function. The estimated mean and dispersion were plugged in the moment estimators of the Gumbel distribution to obtain the quantile of interest. Because the annual maxima of one year of all rivers are correlated, the linear predictor of the generalized linear model was augmented with a random effect for each year. Thus the annual maxima were conditional modelled with a generalized linear mixed model. The result is a model for the annual maxima, which is the basis for predicting the expected flood water for unobserved catchments.

Keywords: Gumbel Distribution, Generalized Linear Model, Random Effects, Annual Maxima