A peaks-over-threshold model for floods with zero-inflated Poisson arrivals

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The peaks-over-threshold (POT) model for hydrological extremes with Poisson arrivals and Generalized Pareto (GP) distributed exceedances remains a popular and useful tool for modelling hydrologic extremes. The use of the Poisson-GP model for flood frequency analysis requires the validation of the Poisson hypothesis: that the distribution of the annual number of flood events may be described by a Poisson distribution. Such hypothesis is not always valid in practical applications.

The present study concerns the use of an alternative distribution for modelling the annual number of floods - the Zero-Inflated Poisson (ZIP) distribution with two parameters. A ZIP-GP model for flood frequency analysis is proposed. This model is less restrictive than the Poisson-GP model since it allows for a more accurate description of the occurrence process in a POT framework if the fraction of years with no exceedances is significantly higher than the theoretical density at zero of the Poisson distribution. Applications of the ZIP-GP model to flood data from Northern Portugal and the evaluation of its performance relative to the Poisson-GP model, including assessments of quantile uncertainty, are presented. The results show that, overall, the ZIP-GP model outperforms the Poisson-GP model, especially for lower quantiles, hence the ZIP distribution is a valid alternative to the Poisson distribution for modelling the annual occurrence counts of peaks in a POT approach for flood frequency analysis. Moreover, despite the ZIP having one more parameter, there is no increment in uncertainty for higher quantiles of the ZIP-GP model.