Geophysical Research Abstracts, Vol. 8, 04597, 2006
SRef-ID: 1607-7962/gra/EGU06-A-04597

Non-stationary flood frequency analysis in the context of climate variability

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The paper proposes an implementation of an extended Gumbel distribution in a non-stationary extreme discharge study. Three different types of time dependant functions are established for both the Gumbel dispersion and location parameter. Among the three types, a modified logistic regression function is applied to the sensitive dispersion parameter. Generalized Reduced Gradient (GRG) method and Simulated Annealing (SA) are successively employed as optimization algorithms for parameter estimation towards an exploration of the maximum likelihood. Based on the extended Gumbel distribution, significance tests and trend analysis are carried out through Mann-Kendall and bootstrap re-sampling successively. Discharge data, made up of annual and seasonal maxima obtained from ten gauging stations located in southern Germany, is used as a case study.

The results demonstrate satisfactory non-stationary parameter fitting and flood estimation. The study proves non-stationarity in observations ought to be considered in estimation schemes. The study is an attempt to offer an alternative solution for a more reliable estimation of the design return flood for engineering purposes. Through the extended non-stationary setting, the study gives an impression of the impact of climate change on flood occurrences and magnitudes. It can also serve as a useful tool for studying climate change scenarios along with climate model simulations.