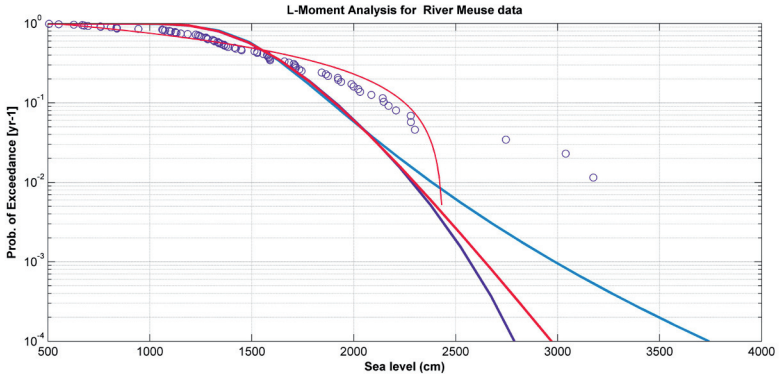
Multivariate -, extreme value - and Bayesian statistical models in flood risk analysis

SUMMARY



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Delft Cluster project 04.30 Flooding

THE REASON FOR THE RESEARCH

Extreme quantile estimates of environmental variables, such as wind, waves, discharge and sea level, corresponding to return periods of the order of 50 to 10,000 years are utilized in the design and assessment of civil engineering infrastructures. In this subpackage new methods are explored to improve the quantile estimation, based on multivariate theory, extreme values statistics and Bayesian analysis.

THE PLAN OF THE PROJECT

The peaks-over-threshold (POT) method is a widely used approach for extreme value estimation that includes several of the largest order statistics exceeding a sufficiently high threshold in the available data. A greater amount of data is incorporated in this way, aimed at reducing the sampling uncertainty. The POT approach has received considerable attention since it has been shown that the Pareto distribution (GPD) arises as the limiting distribution of peaks of a random variable. Although the POT method is conceptually simple, its practical applications are confounded by the problem of inhomogeneous data and of selection of a suitable threshold, which is not known a priori.
This problem becomes particularly serious when quantile estimates exhibit large variability with respect to minor variations in threshold. Research is necessary and has started in the second half of 2006 on the variation of quantile uncertainty (bias and variance) as a function of threshold with the purpose of developing empirical criteria for optimal threshold selection. Development of new methods will continue in 2007. In 2008 the newly developed methods will be applied to collected datasets and real case studies, followed by reporting in 2009.
The Bayesian algorithm has only been used recently for signal-analysis problems, starting with the article Bayesian Spectrum and Chirp Analysis in 1983 by Jaynes. There have been successful applications of this algorithm, especially in the field of chemistry. It will be researched how these relatively new Bayesian methods can be applied in the field of flood risk analysis.

THE RESULTS OF THE PROJECT

Until now the bootstrap method has offered a simple approach for statistical uncertainty analysis when only a single random sample is available. It is however well known that the standard non-parametric version of Efron's bootstrap method is rarely applicable to extreme quantile estimation, because the available sample may not contain any observations in the region of tail extrapolation. The above proposed avenues of research are expected to result in the development of specific algorithms that will be able to alleviate these difficulties to some extent.