Geophysical Research Abstracts
Vol. 12, EGU2010-8092, 2010
EGU General Assembly 2010

Regional extreme storm surges hazard assessment

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The estimation of probability of occurrence of extreme storm surge is a fundamental input in order to ensure the defence of coastal areas from flooding and to design coastal protections. Traditionally, extreme value theory is applied to single-site series of extreme surges observations in order to estimate the probability of occurrence of extremes events at that particular site. Unfortunately, single site analysis gives very uncertain estimation of extreme quantiles, mainly due to the fact that the observation periods are usually dramatically shorter than return level one wish to estimate. Indeed, the sampling uncertainty can strongly bias the estimation (i.e. very extreme surges observed on a short series seeming to be outliers).
In order to reduce this uncertainty, one idea is to collect information not only from a single-site series but from all the (statistically) similar available series of observation. This approach is known as Regional Frequency Analysis (RFA). The use of RFA is widely increasing in geosciences (hydrology, meteorology), but few applications have been attempted yet for extreme surge estimation. The aim of this paper is thus to verify the applicability of Regional Frequency Analysis to extreme storm surges.
A Regional Frequency Analysis of French Atlantic extreme storm surges is thus provided. The surge data from 18 French harbours were collected into a regional database. The series span a period of 30 years in average, with the longest series (at Brest) going back to XIXth century. The series are analyzed in order to extract stationary and independent samples of extreme surges (peaks over a given threshold). The (statistical) homogeneity of 18 samples has been tested via heterogeneity and discordancy measures based on L-moments. Homogeneous regions have been identified, and a surge-index pooling method is defined, in analogy to the flood-index method, in order to merge information on frequency of occurrence of surges from all the sites. Finally, a regional frequency distribution, here a Generalized Pareto Distribution, has been estimated, allowing the regional estimation of extreme surge in any site of the database (theoretically even in un-gauged site).