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Development of a target-site based regional frequency model using historical information

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Nuclear power facilities in France were designed to withstand extreme environmental conditions with a very low probability of failure. Nevertheless, some exceptional surges considered as outliers are not properly addressed by classical frequency analysis models.
If available data at the site of interest (target-site) is sufficiently complete on a long period and not characterized by the presence of an outlier, at-site frequency analysis can be used to estimate quantiles with acceptable uncertainties. Otherwise, regional and historical information (HI) may be used to mitigate the lack of data and the influence of the outlier by increasing its representativeness in the sample. several models have been proposed over the last years for regional extreme surges frequency analysis in France to take into account these outliers in the frequency analysis. However, these models do not give a specific weight to the target site and cannot take into account HI.
The objective of the present work is to develop a regional frequency model (RFM) centered on a target-site and using HI. The neighborhood between sites is measured by a degree of physical and statistical dependence between observations (with a prior confidence level). Unlike existing models, the obtained region around the target site (and constituting the neighboring sites) is sliding from a target-site to another. In other words, the developed model assigns a region for each target site.
The idea behind the construction of a frequency model favoring target sites and the principle of moving regions around these target-sites is the original key point of the developed model. A related issue regards the estimation of missed and/or ungauged surges at target-sites from those of gauged potential neighboring sites, a multiple linear regression (MLR) is used and it can be extended to other reconstitutions models. MLR analysis can be considered conclusive only if available observations at neighboring sites are informative enough and reconstitution results meet some criteria during the cross-validation process.
The developed model is compared to two existing models applied on French coastal sites where exceptional surges (outliers) were induced by violent storms. The Peaks-Over-Threshold model (POT) with the General-Pareto distribution (GPD) is used. The developed RFM using HI gives outliers a better representation in samples. 1000-year quantiles are significantly higher, confidence intervals are narrower and the fitting results for high surge return periods are more adequate.