



Extraction and use of historical extreme climate databases for nuclear power plants safety assessment

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Safety assessments of nuclear power plants (NPPs) related to natural hazards are a matter of major interest to the nuclear community in France and many European countries. Over the past few decades, France has experienced many of these events such as heat waves (2003 and 2006), heavy snowstorms (1958, 1990 and 1992), storms which have given rise to heavy rain and severe floods (1992, 1999, 2010), strong straight-line wind and extreme marine surges (1987, 1999 and 2010) much larger than the other local observations (outliers).

These outliers had clearly illustrated the potential to underestimate the extreme surges calculated with the current statistical methods. The estimation of extreme surges then requires the use of a statistical analysis approach having a more solid theoretical framework and using more reliable databases for the assessment of hazards to design NPPs to low or extremely low probabilities of failure. These databases can be produced by collecting historical information (HI) about severe climatic events occurred over short and long timescales. As a matter of fact, natural hazards such as heat waves, droughts, floods, severe storms and snowstorms have affected France and many European countries since the dawn of time. These events would have been such horrific experiences that if they really occurred, there would be unmistakable traces of them. They must have left clues. These catastrophic events have been unforgettably engraved in people's minds and many of them have been traced in archives and history textbooks. The oldest events have certainly left clues and traces somewhere in the geological layers of the earth or elsewhere. The construction of the historical databases and developing probabilistic approaches capable of integrating them correctly is highly challenging for the scientific community (Translating these geological clues to historical data to build historical databases that can be used by the statistical models is a different challenging story).

In this work, we suggest a HI based statistical model POTH: Peaks-Over-Threshold method with HI. Two kinds of historical data can be used in the POTH method: classical Historical Maxima (HMax) data, and Over a Threshold Supplementary (OTS) data. In both cases, the data are structured in historical periods and can be used only as complement to the main systematic data. The POTH frequency model is applied with the Renext tool developed by the French Institute for Radiological Protection and Nuclear Safety (IRSN). The Renext software was applied to a case study from France, at the La Rochelle site where the storm Xynthia induced an extreme surge (outlier), to illustrate its potentials and to analyze the impact of the use of HI on the extreme surge frequency estimation. The use of historical data, although often imprecise, gave the outlier a better representation in the sample and the characteristic 'outlier' of the Xynthia event has disappeared. The POTH fitting results for extreme surge return levels at the La Rochelle site for high return periods are quite satisfactory.