How historical information can improve estimation and prediction of extreme coastal water levels

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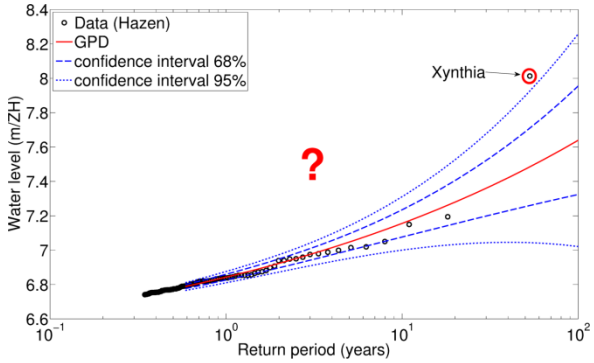
Abstract:
The knowledge of extreme coastal water levels is useful for coastal flooding studies or the design of coastal defences. While deriving such extremes with standard analyses using tide gauge measurements, one often needs to deal with limited effective duration of observation which can result in large statistical uncertainties. This is even truer when one faces outliers, those particularly extreme values distant from the others. In a recent work (Bulteau et al., 2014), we investigated how historical informationof past events reported in archives can reduce statistical uncertainties and relativize such outlying observations. Weadapted to the specific case of coastal water levels a Bayesian Markov Chain Monte Carlo method initially developed in the hydrology field (Reis and Stedinger, 2005). We applied this method to the site of La Rochelle (France), where the storm Xynthia in 2010 generated a water level considered so far as an outlier. Based on 30 years of tide gauge measurements and 8 historical events, the results showed a significant decrease in statistical uncertainties on return levels when historical information is used. Also, Xynthia's water level no longer appeared as an outlier and we could have reasonably predicted the annual exceedance probability of that level beforehand (predictive probability for 2010 based on data till end of 2009 of the same order of magnitude as the standard estimative probability using data till end of 2010). Such results illustrate the usefulness of historical information in extreme value analyses of coastal water levels, as well as the relevance of the proposed method to integrate heterogeneous data in such analyses.



Classical extreme value analysis on La Rochelle tide gauge measurements. The outlying observation circled in red (Xynthia's observed water level) leads to large uncertainties on extreme return levels estimates.

Reference:

Bulteau, T., Idier, D., Lambert, J., Garcin, M. (2015). How historical information canimprove estimation and predictionof extreme coastal water levels: application to the Xynthia event atLa Rochelle (France). Nat. Hazards Earth Syst. Sci., 15, 1135-1147.
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