Sea Level Trend as Covariate for Extreme Value Analysis and Forecasting at the Operational Level

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INTRODUCTION

An exploration of the performance of time-dependent extreme value models to predict the probability of annual highest water levels (HHL) is presented. The study employs long-term projections for design water levels obtained from a statistically based, time-dependent and non-stationary extreme value analysis (EVA) model. This model is developed using the Markov Chain Monte Carlo (MCMC) method and is based on data collected from the National Data Buoy Center (NDBC) for the Ohio River at the Battery, New York (NY) station. The approach is designed to provide a clear and measurable global effect of a change in base sea level on extreme water levels, as opposed to a Bayesian approach, see for example (Lempert et al., 2011). We anticipate changes in water levels and other meteorological parameters (temperature, wind speed, and others) to impact sea levels. The study is intended to explore effective and judicious methods to effectively integrate long-term sea level trends into extreme value analysis at the operational level in the face of sea level rise.

METHODLOGY

The guidelines of all the time dependent models come to comprise so called “base case”. The base case is determined in a manner similar to a classical flood-inference model (CIEM), as explained in (Lempert et al., 2011). Fitting of the time dependent models relies on the Method of Maximum Likelihood (ML) and Markov Chain Monte Carlo (MCMC) is used. An overall trend model is used to correct the data set for long-term trends and other factors. The effect of these factors is to provide consistent future design water levels.

The baseline scenario for the analysis is the 2003 reference case, and the future scenarios examined are the year 2050 as currently simulated by the GFDL and EC models. This study is intended to explore effective and judicious methods to effectively integrate long-term sea level trends into extreme value analysis at the operational level in the face of sea level rise.

RESULTS

This study acknowledges that the extreme events investigated are not necessarily design events. It is clear that there are many high water levels that are not necessarily design events. A clear and measurable global effect of a change in base sea level on extreme water levels, as opposed to a Bayesian approach, see for example (Lempert et al., 2011). We anticipate changes in water levels and other meteorological parameters (temperature, wind speed, and others) to impact sea levels. The study is intended to explore effective and judicious methods to effectively integrate long-term sea level trends into extreme value analysis at the operational level in the face of sea level rise.

CONCLUSIONS

The present study seeks to compare the confidence of displaying a time dependent extreme value model to quantifying the error made by using a traditional, non-stationary extreme value model. The study is structured to provide a framework for assessing the performance of time dependent EVA models when applied to design water levels.

- **Figure 1**: The traditional extreme value model (GEVD) is plotted against the new time-dependent EVA model (GEVD-T). The traditional model, which is based on the historical record of water levels, is unable to capture the accelerating trend in water levels.

- **Table 1**: Comparison of results for different time horizons. The new time-dependent EVA model is shown to provide a clear and measurable global effect of a change in base sea level on extreme water levels.

- **Figure 2**: An example of the predicted future water levels for the Battery, NY station. The results are compared to the historical data and show a clear trend towards higher water levels in the future.

- **Table 2**: Summary of results for the Ohio River at the Battery, NY station. The new time-dependent EVA model is shown to provide a clear and measurable global effect of a change in base sea level on extreme water levels.

**REFERENCES**
