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

Jean Toilliez (1) and Segolene Fay (2)

(1) COWI North America | Ben C. Gerwick, Inc. - United States (jnot@cowi.com), (2) European Institute for Marine Studies (IUEM)

An exploration of the performance of time-dependent extreme value models to predict the return levels and periods of water levels (WL) is presented. The study compares the long-term projections for design water levels obtained from a stationary and time-dependent generalized extreme-value distributions (GEVD and GEVDT, resp.). Data is extracted from 12 NOAA coastal locations in the continental United States and consists in mean sea-level (MSL) and monthly highest water levels.

In this context, the usefulness of a time-dependent extreme value model holds in its ability to capture a mean long-term trend and change in variance in the signal. As such, this effort continues on the results obtained by Menendez (2009), who focused on inter-annual variability, and others. By integrating a local or global sea-level trend (SLT) as a covariate or as a linear component, the study seeks to establish the engineering value of a time-dependent model over the more frequently used stationary GEVD, ranking and least square fitting methods. In this particular context, we show that in a majority of cases, to date and according to this method, there does not appear to be a sufficient amount of information recorded by tidal gauges to observe and capture a significant amount of variability in the signal.

Therefore, in most cases, we show that the linear superimposition of return levels with a given offset due to a change in base sea-level appears to be a valid method to estimate long-term, future design water levels. Nonetheless, the results of this historical data assessment indicate that in some instances, a significant level of variability in the frequency or magnitude of extremes is observed. In that case, the difference made between a linear model and a time-dependent can become significant over the long-term, and a time-dependent model is superior. A range of SLT projections are explored based on US Federal and International guidelines.

This effort focuses on the application of extreme value models at the operational level. It emphasizes on routine applications in marine structure design in the US. It is intended to explore effective and judicious methods to effectively integrate long-term, sea-level trends in the design of marine structures and to engage in a discussion over the handling of the variability of design parameters in coastal engineering practice.