MULTIVARIATE COASTAL FLOOD RISK ALONG THE US PACIFIC

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INTRODUCTION

Urban coastal flooding is an increasing humanitarian and socioeconomic hazard. Flood assessments do not typically consider multivariate (marine and hydrologic) and multi-pathway (e.g., precipitation-surge, overtopping-overflow, surface-sewer) flooding, which may amplify coastal hazards and vulnerability. Notably, flood extent is underestimated when compounded hydrologic and marine impacts are not considered (Chen and Liu, 2014).

Previous multivariate flooding studies typically consider the joint impacts of storm surge and fluvial sources. However, there is a paucity of work that considers precipitation (P), wave, and observed water level (OWL) impacts (Lucey and Gallien, 2022). Various data sampling methods exist within literature and practice (but their influence on risk estimates is often overlooked. Additionally, uncertainty sources such as record length (Tong, 2015), sampling strategy (e.g., Lucey and Gallien, 2022), or gauge selection require further exploration.

This study explores multivariate flooding caused by marine water levels, precipitation, and waves along the U.S. Pacific Coast while considering uncertainties in data sampling, precipitation source, record length, and distribution selection impart on risk estimates.

METHODS

MvCAT is used to fit and select marginal and copula distributions (Sadegh et al., 2017). Wave measurements are converted to runup ($R_{2\%}$, Stockdon et al., 2006) and added to OWL to produce total water level (TWL). Statistics and return periods for OWL-P, TWL-P, and OWL-$R_{2\%}$ are developed for the marginal (M), conditional, and bivariate cases.

Sampling impacts are considered using annual maximum (AM), annual coinciding, wet season monthly, and monthly coinciding samplings. Event estimates developed from different, neighboring precipitation gauges will be compared to assess data source uncertainty. Record length uncertainty is explored using withholding studies for tide gauges with long observational records (e.g. San Francisco).

PRELIMINARY RESULTS

Nelsen and BB5 copulas passed the Cramer-von Mises test for OWL-P and TWL-P cases. Preliminary results show strong agreement in risk estimates across copulas (Figure 1). In San Francisco, ten year return period flood events are highly uncertain with reduced data length of less than 70 years (Figure 2). Generally, return period estimates converged above 70-years (Figure 2).

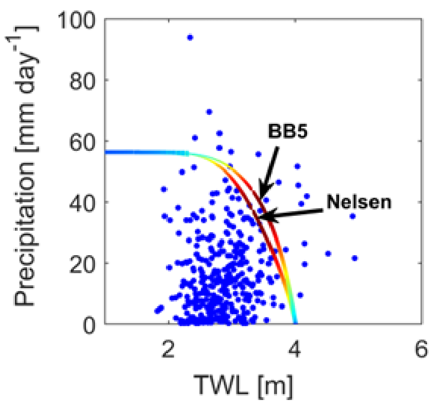

Figure 1 - 10-year TWL-P isolines from copulas fitted to observation pairs created with AM sampling

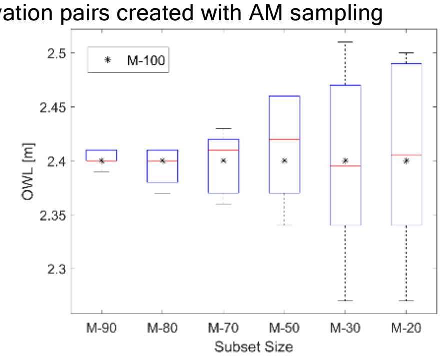

Figure 2 - SF 10-year OWL M estimates based on subsets of 90-, 80-, 70-, 50-, 30-, and 20- subsequent years with black stars indicating estimates from the 100-year record

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