**The importance of multivariate statistical analysis to simulate compound flood hazards in North Miami**

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**Abstract**

Miami-Dade County (MDC) is highly vulnerable to the recurrent effects of meteorological, hydrological, and oceanographic flood drivers due to geographical location, flat elevation, highly managed surface-water system, shallow water table, and higher sea levels, posing a significant threat to critical infrastructure and human safety. Coupled H&H numerical models are essential tools capable of simulating complex surface-subsurface water interactions, supporting the development of comprehensive flood vulnerability and damage assessment in the region. While design events and intensities are generally considered in simulations to provide input of current and future conditions, most scenarios use average record values and a range of return periods, frequently overlooking the joint distribution and “most-likely” combination drivers.

In this paper, we adopt an integrated approach by linking a copula approach developed by Jane et al. (2020) with a coupled H&H framework to evaluate the compound flooding potential of rainfall, tides, and groundwater mechanisms for the Arch Creek Basin located in North Miami, Florida (US). This region is particularly prone to hurricanes, intense precipitation events, coastal surges, king tides, high groundwater tables, sunny day flooding and SLR. An ensemble of design events from a copula-based 100-year joint probability contour are used as boundary conditions in a loosely-coupled model using the hydrologic and hydraulic model FLO-2D and groundwater model MODFLOW-2005 to simulate the interaction of the flooding processes. A multivariate statistical analysis to model the joint distribution of flood drivers in the joint tail regions was applied, followed by adopting a copula-based approach to calculate the “most-likely” combinations of flood drivers and ensemble realizations of design events for a 100-year return period. In addition, an economic flood damage assessment is presented based on the combination that causes most damage to property assets.