**Can an event-based approach provide robust estimates of extreme water levels along the transition zone of the Suwannee River, Florida?**

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**Abstract**

Transition zones are estuarine and coastal environments where the interaction of river discharge and downstream ocean level can exacerbate water levels. To robustly assess the flood hazard in these zones we must account for the joint probability of the fluvial and oceanic drivers as well as the physical compounding of the processes. Established bivariate statistical models can provide long synthetic records of physically plausible discharge - ocean level events that act as boundary conditions for well validated hydrologic models. However, propagating a larger number of events through a hydrologic model is often prohibitively computationally expensive.

Recently developed hybrid approaches linking bivariate statistical analysis and hydrologic models offer a computationally viable method for estimating flood hazard in transition zones by reducing number of hydrologic model runs. Event-based hybrid approaches assume the water level produced by a joint return period discharge - downstream ocean level design event is representative of this condition. Typically, the event on the joint probability contour implied most likely by the observed data is taken as the design event. The surrogate-based hybrid approaches are more complex but remove this assumption. Along-river levels of a large sample of plausible extreme events are estimated by a surrogate (or meta) model, fit to a carefully chosen subset of the realizations propagated through the hydrologic model. In contrast with the event based approach, estimating along river levels for many simulated events allows return period water levels along the river to be calculated empirically.

We present a transferable surrogate-based hybrid framework for estimating the location of transition zones and apply it to the Suwannee River, Florida. Three surrogate models are evaluated, highlighting the enhanced performance of non-linear models to accurately capture discharge - ocean water level interactions along the river. To gauge the robustness of the event-based approach at the site, return water levels of the single “most-likely” design event and an ensemble of possible design events are compared with those from the proposed approach. The “most-likely” design event’s return water levels lie close the empirical return levels for most of the transition zone.