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Compound Flood Hazard Scenario for Coastal Electric Power-grid Substations in Connecticut, USA

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Compound flood hazards triggered by combined occurrence of extreme precipitation and storm surge during high tides, exacerbated by future sea level rise, are likely given the changing climate and adverse anthropogenic activities. Risk estimates associated with these extreme scenario events are likely to be significantly higher than standard evaluation of individual hazard scenarios. However, there have been relatively few efforts to quantify the vulnerability assessment and mitigation of compound hazards. This study focuses on assessing coastal power-grid substation flood vulnerability in Connecticut (USA) caused by a hypothetical compound hazard induced by hurricanes causing heavy precipitation, coastal winds and surges. Local electricity supply depends on the uninterrupted functioning of the substations and so does the day to day activities of the local communities. A cascade of events of different magnitudes has been evaluated to measure the power outcomes and responses for both coastal and riverine flooding by using the HECRAS 2D hydrodynamic model. A distributed hydrologic model CREST-SVAS was forced with weather analysis data from the WRF model for hurricane scenarios to facilitate the upstream boundary conditions of the HECRAS model with stream flow predictions. The downstream boundary condition for coastal sea level is based on coastal tide, storm surge, and sea level from NOAA and the WRF winds during each scenario. The significant outcome of this study represents the dimensions of flood risks due to compound extreme events, in particular, the vulnerability of the substations during these events. This approach offers an estimate of the potential compound hazards impact, which is vital to developing mitigation strategies. This will allow researchers and stakeholders to analyze the risk factor of combined hazards and prepare for taking necessary mitigation measures to protect the vulnerable infrastructure within the flood zone. This study has broader impacts by providing new insights on the impacts of inevitable future hazards and by developing a framework for assessing risk factors of our modern infrastructures and facilities in vulnerable coastal areas throughout the world.