Advancing joint modeling of tropical cyclone wind, surge and rain impacts – now and in a changing climate

Simona Meiler[1,2], Kerry Emanuel[3] and David N. Bresch[1,2]

[1] Institute for Environmental Decisions, ETH Zurich, Switzerland

[2] Federal Office of Meteorology and Climatology MeteoSwiss, Switzerland

[3] Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA

Intense precipitation from tropical cyclones (TCs), typically accompanied by wind-driven storm surges and highly destructive winds, constitutes a significant threat for compound flooding and wind-driven socio-economic impacts in many coastal regions worldwide. So far, TC risk assessment methods primarily consider wind as the driving physical hazard. However, these methods likely underestimate the compounding impacts from multiple sub-hazards (wind, storm surge, and rain/flood). Further, it is crucial to understand how TC sub-hazard risk will shift and intensify in a warming climate. We thus advance TC impact modeling by explicitly representing TC rainfall-induced freshwater flood, TC wind-driven storm surges, and direct impacts from TC wind in a chained modeling framework for present and future climate. We use a large set of synthetic TCs generated from historical climate data and for future climate scenarios. The socio-economic impacts from the TC flood (rainfall-induced and storm surge) and wind sub-hazards together are assessed using a state-of-the-art, open-source probabilistic damage model (CLIMADA). We present our coupled, physics-based modeling approach for the coastal area of Metropolitan Manila (PHL). Ultimately, our advances in TC impact modeling can be applied in vulnerable coastal regions worldwide, enabling better-informed adaptation decisions and mitigation strategies.