MONTE CARLO SIMULATION OF BARRIER-ISLAND SYSTEMS AND TSUNAMI HAZARDS

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INTRODUCTION & METHODS

Robust characterization of the future tsunami hazard is critically important for resilient planning and engineering in coastal communities prone to tsunami inundation. The hazard from earthquake-generated tsunami waves is not only determined by the earthquake's characteristics and distance to the earthquake area, but also by the geomorphology of the nearshore and onshore areas, which can change over time. In coastal hazard assessments, a changing coastal environment is commonly taken into account by increasing the sea-level to projected values (static). However, sea-level changes and other climate-change impacts influence the entire coastal system causing morphological change (dynamic). Here, we present the modeling framework and results initially published in Weiss et al. (2022), which employs within a Monte Carlo framework the barrier island-marsh-lagoon-marsh evolution model of Lorenzo-Trueba and Mariotti (2017) and the tsunami model Geoclaw (e.g., LeVeque et al. 2011). We compare the runup of the same suite of earthquake-generated tsunamis to a barrier system for statically adjusted and dynamically adjusted sea level and bathymetry over the period from 2000 to 2100. We employ Representative Concentration Pathways 2.6 and 8.5 without and with treatment of Antarctic ice-sheet processes (e.g., Kopp et al. 2017) as different sea-level projections.

SELECTED RESULTS

Figure 1 presents tsunami runup from a Mw 8.8 earthquake under the RCP 2.6 scenario. In the case of static bathymetry (a), changes in runup from 2025 to 2100 are generally consistent with sea-level changes, which is the only modeled variable for static bathymetry. Here, the variation in runup for all sea level treatments and at all time intervals is fairly small, ranging from 0.91 to 1.04 m. Yet, as the modes of the runup densities move toward larger runup values over time, they become more broadly distributed across runup values. For the dynamic case (b), the probability densities again skew toward larger values over time. However, when compared to the static bathymetry results, the ranges of runup for the dynamic bathymetry have an order of magnitude wider spread, varying from 0.2 m to 3.8 m and significantly exceed the range of sea-level change for the respective time periods.

CONCLUSIONS

Our results indicate that the tsunami runup hazard for the dynamic case is substantially larger than for the static case. Furthermore, we show that nonlinear and complex responses of the barrier-island system to climate change profoundly impacts the tsunami hazard. In our presentation, we will highlight coastal adaptation opportunities as informed by these results.

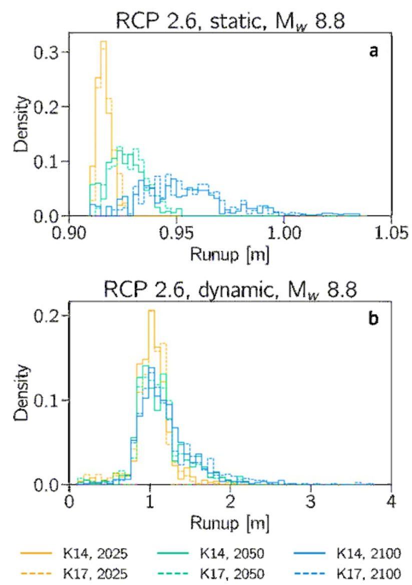

Figure 1 - Probability densities of Mw 8.8 tsunami runup in a barrier-island system under RCP 2.6 for (a) static and (b) dynamic bathymetry, and for sea-level projections without (K14) and with (K17) treatment of Antarctic Ice-sheet processes. Modified from Weiss et al. (2022).

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