災害科学国際研究所
IRIDeS
International Research Institute of Disaster Science

Collaboration with the University of Hawaii on large swell and hurricane waves for disaster mitigation and coastal zone planning (2016/2/28-3/10)

Theme：Large swell waves, hurricane, hazard mitigation, numerical modeling
Location：Honolulu, Hawaii, USA

IRIDeS staff member Volker Roeber joined a collaborative research effort with the Department of Ocean & Resources Engineering and the Department of Oceanography at the University of Hawaii focusing on the validation and application of numerical models for disaster prevention.
This year's El Niño winter produced a series of very strong storms in the North Pacific. Unusually large swell waves have hit the Northshores of the Hawaiian Islands and have caused massive beach erosion, as well as damage to coastal defenses and harbor infrastructure. Coastal roads were overtopped by surges, which observers described as tsunami waves rather than storm waves. Several people were caught in unexpected wave runup despite the warnings by local authorities and lifeguards.
Our study shows that unusually large wave runup is often attributed to infragravity waves. In addition, locations near fringing reefs such as Hawaii are susceptible to IG wave amplification, which exacerbates the flood risk. Roeber & Bricker (2015) recently demonstrated that IG waves could even result in destructive tsunami-like bores. Field observations show that the fundamental oscillation period of Oahu's Northshore of 23 min is not only excited by tsunamis but also by large swell waves. Comparisons between field measurements in Haleiwa Harbor and calculations with the numerical model BOSZ (developed by Volker Roeber) give good agreements over the entire wave spectrum. BOSZ is capable of handling wave processes over complex reef structures and accurately predicts water level fluctuations in harbors.

Encouraged by these results, Volker Roeber and the research group around Prof. Fai Cheung completed a study, which will be published in the proceedings of the 7th Civil Engineering Conference of the Asian Region (CECAR7). The paper describes a probabilistic approach for mapping of coastal flood hazards associated with sea-level rise and storm intensification toward the end of the 21st century. With an elevated sea level, the natural protection of fringing reefs is compromised and individual waves can dramatically increase the flood hazard through overtopping on coastal terraces. The primary goal of this ongoing project is to develop disaster resilient measures for using relevant codes, standards, and local jurisdiction flood regulations as a basis for reducing building and infrastructure vulnerability to natural hazards. The study shows that intensive numerical modeling down to the scale of individual waves is necessary to address these issues. An extension of this study is in preparation.

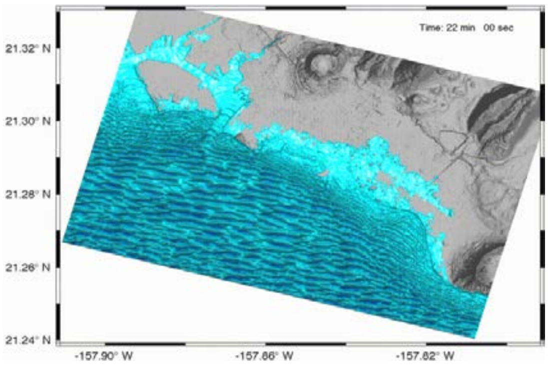

Figure 1:
Hurricane waves traveling on top of a probabilistic storm surge scenario with combined sea-level-rise and MHHW of 0.93 m with respect to MSL.
Wave setup and runup can cause flooding far beyond the storm surge limit. The example shows the Southshore of Oahu with downtown Honolulu and the touristic center of Waikiki.
Snapshot from BOSZ model.

Reference: Roeber, V. and Bricker, J.D. (2015). Destructive tsunami-like wave generated by surf beat over a coral reef during Typhoon Haiyan. Nature Communications, 6, 7854, doi:10.1038/ncomms8854.

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