



Boulders shifted during Supertyphoon Haiyan (7–9 Nov 2013) – Observations from Eastern Samar (Philippines)

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Boulder fields record maximum magnitudes of coastal flooding during strong storms or tsunamis. Such a maximum magnitude tropical cyclone – Supertyphoon Haiyan – made landfall in the Philippines on 8 November 2013. During this typhoon, longshore transport of blocks of up to 180 t and upslope transport of boulders weighing up to 23.5 t to elevations of 10 m above mean lower low water level was documented in a combined analysis of bi-temporal satellite images and field survey at Hernani, Eastern Samar. Boulders were mapped and their volumes were derived from 3D models based on DGPS and structure-from-motion. Initiation-of-motion approaches show that boulders were shifted by flow velocities of 8.9–9.6 m/s, which significantly exceeds depth-averaged flow velocities given by a local coupled hydrodynamic and wave model (Delft3D) of the typhoon with a maximum <1.5 m/s. These results, in combination with recently published phase-resolving wave models and survivor videos from Hernani, support the hypothesis that infragravity waves induced by the typhoon, which are not resolved in phase-averaged storm surge models, were responsible for the exceptional high-velocity flooding in Eastern Samar. Our findings show that tsunamis and hydrodynamic conditions induced by storms may shift boulders of similar size and, therefore, demand a careful re-evaluation of storm-related transport where it, based on the boulder's sheer size, has previously been excluded.