Geophysical Research Abstracts
Vol. 19, EGU2017-16868, 2017
EGU General Assembly 2017

Experimental modelling of wave amplification over irregular bathymetry for investigations of boulder transport by extreme wave events.

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During the winter of 2013-2014 the west coast of Ireland was exposed to 6 storms over a period of 8 weeks with wind speeds equating to hurricane categories 3 and 4. During this period, the largest significant wave height recorded at the Marine Institute M6 wave buoy, approximately 300km from the site, was 13.6m (on 26th January 2014). However, this may not be the largest sea state of that winter, because the buoy stopped logging on 30th January and therefore failed to capture the full winter period. During the February 12th 2014 "Darwin" storm, the Kinsale Energy Gas Platform off Ireland's south coast measured a wave height of 25 m, which remains the highest wave measured off Ireland's coasts[1].

Following these storms, significant dislocation and transportation of boulders and megagravel was observed on the Aran Islands, Co. Galway at elevations of up to 25m above the high water mark and distances up to 220 m inland including numerous clasts with masses >50t, and at least one megagravel block weighing >500t [2]. Clast movements of this magnitude would not have been predicted from the measured wave heights. This highlights a significant gap in our understanding of the relationships between storms and the coastal environment: how are storm waves amplified and modified by interactions with bathymetry?

To gain further understanding of wave amplification, especially over steep and irregular bathymetry, we have designed Froude-scaled wave tank experiments using the 3D coastal wave basin facility at Queen's University Belfast. The basin is 18m long by 16m wide with wave generation by means of a 12m wide bank of 24 top hinged, force feedback, sector carrier wave paddles at one end. The basin is equipped with gravel beaches to dissipate wave energy on the remaining three sides, capable of absorbing up to 99% of the incident wave energy, to prevent unwanted reflections. Representative bathymetry for the Aran Islands is modelled in the basin based on a high resolution nearshore multibeam sonar survey. Water surface elevation is recorded using twin-wire resistance type wave probes along a shore-normal bathymetry transect as the waves shoal.

Variations in significant wave height and maximum elevation are presented for both regular and irregular bathymetry and for a number of typical North Atlantic sea states. These results are significant for calibration of numerical wave propagation models over irregular bathymetry and for those seeking to understand the magnitude of nearshore extreme wave events.

References

[1] Met Éireann, 2014, Winter 2013/2014: Monthly Weather Bulletin, December issue, p. 1-5. http://www.met.ie/climate-ireland/weather-events/winterstorms13_14.pdf.

[2] Cox, R. et. al., 2016, Movement of boulders and megagravel by storm waves Vol. 18, EGU2016-10535, 2016 EGU General Assembly 2016