The effect of storm waves on boulder transport and shore platform evolution at Bembridge, Isle of Wight.

Linley Hastewell

Department of Geography, University of Portsmouth, linley.hastewell@port.ac.uk

Introduction

The anticipated increase in storm activity and intensity resulting from climate change is set to drive geomorphic alteration to shore platforms and increase the vulnerability of coastal zones. As a result, storm wave impacts on rocky coasts are of increasing interest in terms of understanding coastal change. The key focus of this research is to accurately quantify transport pathways of detached boulders resulting from contemporary storm activity on the intertidal shore platforms at Bembridge, Isle of Wight.

Contemporary storm events have been identified as agents of detachment, entrainment and deposition of boulders across intertidal shore platforms (Paris *et al.*, 2011). The boulders act as signatures for storm intensity (Stephenson & Naylor, 2011), the degree of movement being attributed to the magnitude of the storm event which facilitates mobility.

Existing research in this area focuses on high-energy wave environments such as North Atlantic coastlines (Etienne & Paris, 2010, Cox *et al*., 2012 and Autret *et al*., 2016). Fetch limited coastal zones subjected to low to moderate wave climates have been overlooked despite exhibiting distinct boulder assemblages indicative of storm events, as found at Bembridge.

To better understand the localised impacts of storm activity it is necessary to trace the mobility of detached boulder material. By employing Radio Frequency Identification (RFID) tagging technology in combination with periodic topographic surveys using Differential Global Positioning Systems (DGPS) we have been able to accurately trace and quantify the mobility of coastal boulders resulting from storm wave activity.

Methodology

RFID tags are frequently used to assess the transport potential of coarse clastic sediments (gravels and cobbles) in both fluvial and littoral environments. However, to date, they are yet to be deployed exclusively to monitor boulders; boulder size nomenclature is defined by Blair and McPherson (1999) as clasts with an intermediate axis between 0.25 and 4.1m's, (-8 to -12ϕ).

In total, 104 RFID tags were embedded in boulders across the shore platforms at Bembridge. The location of these tagged boulders was monitored between July 2015 and June 2017. During periodic field surveys tagged boulders were recovered and assigned a DGPS coordinate. Collectively, this data provided a spatial and temporal context to the mobility of boulders resulting from storm activity.

Initial findings

Coordinate data derived from field surveys indicates that storm waves have the ability to produce clasts, quarried from the shore platform edge and transport them across the intertidal zone prior to deposition.

Of the 104 tagged boulders 43% were found to be mobile during the study period. Transport events were initiated by winter storms as indicated in fig1.a & b with an individual clast up to an estimated 10 tonnes being transported 3m in a single event.

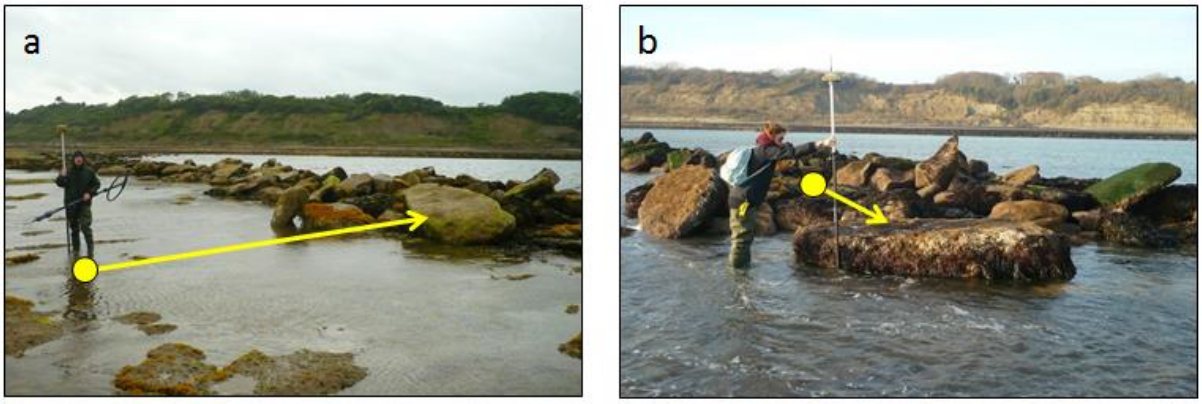

Fig 1 - *Evidence of transport:* ***(a)*** *boulder location recorded in February 2016, identified by yellow circle. Following Storm Katie (27th March 2016) the same boulder was relocated having been overturned 180° and transported landward 7.2m under storm conditions (H_s - 4.2m). Arrow denotes direction of transport.* ***(b)*** *Following Storm Angus (20th November 2016) the boulder was overturned 180° (righted) and transported 2.5m seawards under storm conditions (H_s - 4.0m). The arrow denotes direction of transport. Note: boulder weight is estimated at 5.0 tonnes.*

Coordinate data was further used to create a visual interpretation of boulder mobility. This was achieved using a bespoke Python script to quantify individual boulder transport pathways, fig 1.2. The Python script processes recorded coordinate data and outputs net distance and direction of transport as recorded during each survey. Figure 1.2 identifies a tagged boulder (ID – 1192) which has been transported landward between July 2015 and May 2016 prior to a period of inactivity throughout the second storm season (September 2016 to May 2017). The lack of movement is attributed to the boulder being topographically constrained against another detached clast.

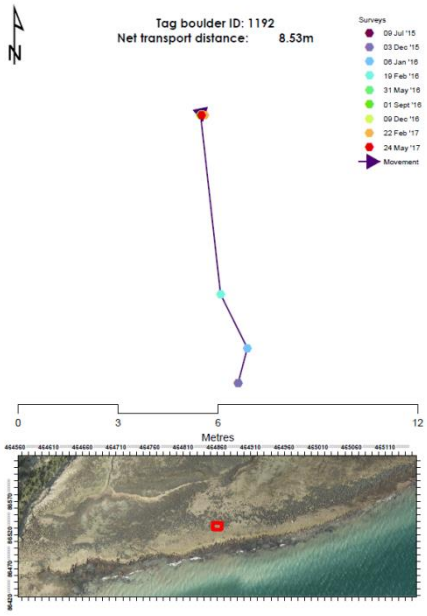

Fig 2 – *Boulder transport pathway: Python script output of recorded boulder coordinate data as recorded throughout the study period.*

Significantly, the RFID technology fared well in spite of the harsh coastal conditions. This is reflected in the favourable tag recovery rates, up to 95%. The prolonged operational functionality of the RFID tags has allowed for the continuation of the field campaign. This will form what is thought to be the first long term use of RFID technology in monitoring the mobility of boulder deposits subjected to contemporary storm activity.

BSG funding

The BSG are thanked for the invaluable financial contribution of the £1,000 postgraduate research grant. This was used to cover the transport costs associated with accessing the field site. The BSG award has helped secure further funding from the Royal Geographical Society.

References

Autret, R., Dodet, G., Fichaut, B., Suanez, S., David, L., Leckler, F., Ardhuin, F., Ammann, J., Grandjean, P., Allemand, P. & Filipot, J. F. (2016). A comprehensive hydro-geomorphic study of cliff-top storm deposits on Banneg Island during winter 2013–2014. *Marine Geology*, *382*, 37-55.

Blair, T. C., & McPherson, J. G. (1999). Grain-size and textural classification of coarse sedimentary particles. *Journal of Sedimentary Research*, *69*(1).

Cox, R., Zentner, D. B., Kirchner, B. J., & Cook, M. S. (2012). Boulder ridges on the Aran Islands (Ireland): recent movements caused by storm waves, not tsunamis. *The Journal of geology*, *120*(3), 249-272).

Etienne, S., & Paris, R. (2010). Boulder accumulations related to storms on the south coast of the Reykjanes Peninsula (Iceland). *Geomorphology*,*114*(1), 55-70.

Paris, R., Naylor, L.A. & Stephenson, W.J. 2011. Boulders as a signature of storms on rock coasts. *Marine Geology, 283* (1-4), 1-11.

Stephenson, W. J., & Naylor, L. A. (2011). Geological controls on boulder production in a rock coast setting: insights from South Wales, UK. *Marine Geology*, *283*(1), 12-24.