Wave transformation within a coral reef lagoon system, Erakor lagoon, Vanuatu

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INTRODUCTION

Small Island Developing States are highly vulnerable to coastal hazards, with Vanuatu ranked the world's most disaster-prone country by the WorldRiskIndex (Garschagen et al. 2016). Coral reefs encircle most of the islands in Vanuatu and provide natural breakwaters for coastal communities by reducing wave energy arriving at the shoreline acting to control both inundation and erosion. Climate Change is projected to both exacerbate coastal hazards and endanger corals. To assess the consequences of these impacts a detailed understanding of the interactions between coral reefs and waves is required. Reef complexity associated with wave breaking is not well understood. The aim of this paper is to better understand the parameters that govern hydrodynamics on fringing reef systems. The interaction between the depth, waves and currents are studied from measurements conducted in Erakor lagoon, Vanuatu. The novelty of the work is the application of longshore wave measurements within a 2Dmodel to simulate the spatial dissipation and breaking parameters, along with morphological changes of the reef.

STUDY SITE

Erakor lagoon (lon: 168.309°; lat:-17.775°) is located in the South-West of Efate Island, Vanuatu. The entrance of the lagoon is an exposed reef break mainly dominated by southeast swell.

Figure 1 – In-situ instruments deployed within Erakor coral lagoon system.

The lagoon system has a constriction creating two-sub lagoons referred to as Ekasuvat lagoon and Emten lagoon (Figure1). Ekasuvat lagoon is closest to the entrance and separated from the ocean by a 750 m long, 100 m wide channel. At the entrance, the reef flat has a gentle slope (~1:100) and it is approximately ~250m wide at the widest point in front of Erakor Island. The reef flat is fully exposed during low tide. The fore reef has a steep slope (~1:10) and its width varies along shore.

METHODOLOGY

Field measurements and numerical modelling are used to evaluate wave transformation and hydrodynamic processes within a coral reef lagoon system. Surf zone waves and wave setup dynamics are compared with field measurements collected on the forereef, reef crest, reef flat and reef channels in the lagoon and numerical model studies. A wave buoy placed outside the reef at 35m deep for a month period and five pressure transducers located at three reef crests and over the reef flat were used to understand cross-shore and alongshore wave variations. Wave parameters such as significant wave height, wave direction and wave period were collected by the wave buoy at 30-minute intervals. Significant wave heights, wave period and water levels were derived from continuous measurements of pressure from the pressure transducer array. The influence of the reef geomorphology on waves and circulation is studied with varying roughness. A correlation between significant wave heights and roughness parameter is given. For many reefs, the circulation is mainly driven by the effects of breaking surface waves (Lowe et al., 2010). Both long waves and short waves are considered in this study. The main drivers of the circulation and their proportion in the contribution to the flow is presented. In addition, the interaction between the water level and waves is considered.

REFERENCES

Garschagen, M., Hagenlocher, M., Comes, M., Dubbert, M., Sabelfeld, R., Lee, Y.J., Grunewald, L., Lanzendörfer, M., Mucke, P., Neuschäfer, O., Pott, S., Post, J., Schramm, S., Schumann-Bölsche, D., Vandemeulebroecke, B., Welle, T. and Birkmann, J. (2016). World Risk Report 2016. World Risk Report. Bündnis Entwicklung Hilft and UNU-EHS.

Lowe, R.J., Hart, C., Pattiaratchi, C.B., (2010). Morphological constraint to waveleng-driven circulation in coastal fringing reef-lagoon systems: a numerical study. Journal of Geophysical Research, 115, C0902