



Developing a storm surge typology for low latitude coral atolls and islands in the Indian and Pacific Oceans

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Background

In low latitudes (100N-100S) storms of hurricane/typhoon intensity are not common. And yet, coral rubble ridges and reef blocks emplaced by storm waves and surges are persistent morphological features on many low-lying atoll islands and reefs in equatorial regions. The purpose of this study is to examine this paradox based on extensive field surveys in Tuvalu central Pacific, and the Maldives central Indian Ocean.

Objectives

The general aim is to develop a storm surge typology for coral atolls and reef islands. Specifically the objectives are: (1) to identify the provenance of storm waves and surges in these two atoll states; (2) to determine the magnitude and frequency of surge events and assess whether previous models used to estimate palaeosurge-event magnitude (based on ridge elevation) is a valid methodology; (3) to investigate the immediate and long-term bio-physical impacts on islands, and their role in island destruction and construction; and, (4) to examine how communities and governments have adapted to surge events in the historic and recent past and what they are likely to do in the future.

Methods

The identification and mapping of storm surge deposits using geomorphologic and sedimentologic criteria; morphostratigraphic analysis and radiometric dating of storm deposits to determine palaeosurge-event frequency together with analysis of historical and contemporary events to develop a long-term record of surge-events and human response in Tuvalu and the Maldives; sequential and on-going monitoring of a massive coral rubble rampart deposited during Hurricane Bebe on Funafuti atoll Tuvalu in October 1972; and, repeated island-beach and reef surveys prior to and following the swell-surge event during May-June 2007 in the Maldives. Both of the latter serve as modern analogues of past surge events, and of how communities and governments have adapted to such events.

Results

Three surge types impact these and other atoll islands in equatorial regions. These are: (1) infrequent tropical cyclones generated within low-latitude boundaries; (2) waves and surges that penetrate into the region from tropical storms and cyclones generated in the adjacent hurricane/typhoon belts to the north and south; and (3) sea-swell and surge set-up that results from extra-tropical and high-latitude low pressure systems, originating thousands of km from the atoll islands. Process characteristics of these events are described and their physical signatures and human impacts assessed in order to develop a storm surge typology for atoll islands.

Conclusions

A storm-surge typology has been developed for low-latitude coral islands and atolls. Three types of storm surge are described. Each type has a different physical impact, human response and risk profile. Whilst the immediate event is generally destructive, storm surges have an important role in island formation and development. Low-lying coral atolls and reef islands have been identified as extreme examples of the potential negative impacts of climate change and sea-level rise, with the atoll states of Tuvalu and the Maldives often being cited as the most vulnerable. Despite such concerns the most common catastrophic natural events that have impacted these states in the last 100 years or so have been associated with storm surges, and this is also likely to be the case in the future.

