Richmond

Re-Surveys of 1972 Hurricane Rampart of Funafuti Atoll, Ellice Islands

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A huge coral rubble rampart 19 km long, 30-40 m wide and up to 4 m high was deposited along the southeastern reef flat of Funafuti Atoll during tropical cyclone 'Bebe' on 21 October 1972. Similar deposits of reef rubble in the form of ridges extending above high water have been reported as a consequence of storms of hurricane intensity in other tropical areas, but few have been resurveyed (Blumenstock, Fosberg and Johnson, 1961; Stoddart, 1974). The Funafuti deposit is much larger than those reported earlier.

In December 1972, six weeks after the hurricane, seven profiles were surveyed across the northern portion of the new rampart. These were initially described by Maragos, Baines and Beveridge (1973) and further details were given by Baines, Beveridge and Maragos (1974). This report documents changes that have taken place in the form, dimensions and position of the rampart since then. In November 1973 profiles 1-7 were re-surveyed and two new transects (1A and 8) established. All profiles except No. 8 were re-occupied in January 1975.

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Rampart migration

Since it first formed, the Bebe rampart has retreated isletward or lagoonward along most of its length (Fig. 1). On all profiles the shore-face was cut back, the bulk of rubble mobilised during recession being washed lagoonward on to the main body of the rampart, which thus maintained its ridge-form, height and coherence.

The changing location of the crest provides an indication of the amount and rate of rampart migration. Between the first and third surveys average landward crest shift was 10-20 m, excepting profiles 7 and 1A which recorded higher values. Excluding these, mean rates of crest movement were 0.7 m/month during the first year and 0.5 m/month during the second year. The most dramatic shift in crest position occurred at profile 7. During 1973 the crest receded at 1.5 m/month and in the following year rampart rubble was distributed across the moat to reach the island shore leaving a crest-less rubble tract on the reef flat. The outer edge of this tract marks the original seaward margin of the storm beach. A similar marker deposit, made up of large calibre fragments, does occur elsewhere on the reef flat, but more commonly the reef flat has been swept clean of rubble leaving no indication of the rampart's former seaward extent (e.g., profile 6). In places, such as around profile 2, recession has progressively exposed massive reef blocks, broken from the reef edge and lifted on to the reef flat during the hurricane, and initially obscured beneath the rampart's ocean side. Such blocks will be moved only during the fiercest storms, and most are likely to remain as isolated indicators of the rampart's early position.

For much of its length the rampart is separated from the islands by a 30-50 m-wide tidal moat which formed at the same time as the rampart. In contrast to the activity along the rampart's ocean side, its inner edge, which drops steeply to the moat, had during the first year remained essentially unchanged in location and fabric since its accumulation, except in the vicinity of profile 7. During the latter part of the second year ocean face rubble had been moved so far landward as to bury the original inner rampart margin and by January 1975 only at profiles 2 and 4 did the inner edge remain intact (Fig. 1).

Morphological change

In 1972, just after the hurricane, the seaward slope of all profiles displayed a markedly convex form – a morphology typically associated with beach accretion or progradation. But, during 1973, profiles took on a concave form as rubble, easily eroded from the over-nourished shore-face, washed on top of the rampart and raised the crest. Crest lowering followed in the 1974-75 period with continued erosion of the now undernourished beach face. In detail, crest heights showed a slight increase during the first year from an average of 3.7m (height above the reef flat) to 3.9 m, but in the second year were reduced to 3.5 m. Profile 7 was an exception; crest elevation between 1972 and 1973 lowered 0.5 m, and then another 2.0 m between 1973 and 1975 as the rampart at this point was broken down to form a crest-less rubble tract.

A small reduction in cross-sectional area of the deposit was noted between surveys. We believe that this loss of material is more apparent than real, and that, except locally where longshore transport can be taken into account, it results from both abrasion of clasts and more efficient packing of particles as selective sorting for size and shape takes place during repeated post-hurricane transport and deposition. Little material has been lost oceanward down reef-edge grooves, a conclusion reinforced by SCUBA observations of the offshore buttress and terrace zones. In 1973 and 1975 there was no significant increase in the amount of sub-marine rubble over that noted in 1972. The abnormally large reduction in cross-sectional area for profile 7 has been transported in a NW direction into an area beyond the original northern extremity of the hurricane bank (inset, Fig. 1). Here fresh rubble has piled up against the island shore and contributed to the accumulation at profile 8, which in 1972 was located some 20-30 m north of the main rampart.

Increase in island area

At the present time (1975) the Bebe rampart, throughout much of its length, is set back some 20 m from the reef edge and 30-50 m seaward of the

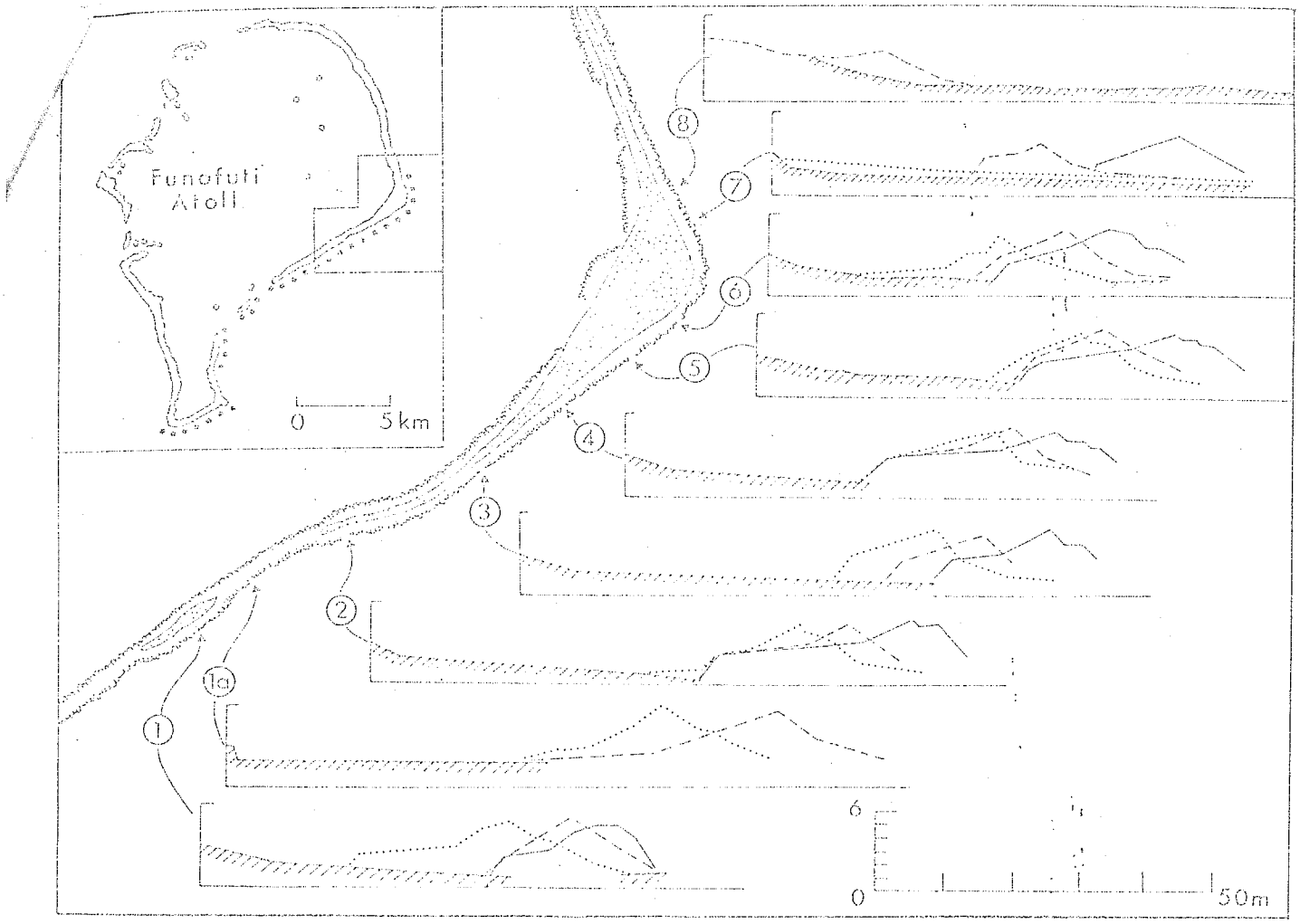

FIGURE 1
Location of storm beach profiles and plots of profiles surveyed in: December 1972, solid lines; November 1973, dashed lines; January 1975, dotted lines. Reef flat and breccia shaded. Reef flat is approximately at low-water level. Profile scale in metres. Inset shows extent of Hurricane Bebe rampart on Funafuti Atoll, Ellice Islands, 8° S 179° E.

islands. Our observations reveal the rate at which the rampart is retreating lagoonward. This retreat, caused by erosion of the beach face and deposition on top of and over the bank, is expected to continue, but at a lessening rate as its distance from the reef edge increases. The tidal moat is expected to be transgressed by the advancing rubble, prior to its final accumulation against the island shore. The shore-deposited ridge banked up against the island at profile 8 (Fig. 1) gives some indication of the contribution which we expect the remainder of the storm beach to make to the land mass of the windward side of the atoll. Such a development would be consistent with the model of atoll island formation proposed by Cloud (1952). It is quite conceivable that in time the total land area of Funafuti atoll will be increased by from one-fifth to one-third its present amount as a direct result of the fresh rubble contributed to the reef flat during Bebe and reworked landward in the years following the hurricane.

Sufficient has been learned of the movement of this deposit for us to suggest that the people of Funafuti, concerned at the loss of much of the old hurricane bank which had served to protect their low-lying habitat, may now anticipate rebuilding or strengthening of that sea defence. Indeed, the village elders had believed this; a legend tells of a sea goddess, Sina, whose task this is, though she exacts a price in human lives, six in 1972.

We compliment Sina for producing this unusual geomorphological phenomenon

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