Scale of disaster and topographic effects of the 2004 Indian Ocean Tsunami on atoll reefs and islands in Maldives

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Following the tsunami caused by the Sumatra-Andaman earthquake of 26 December 2004, the Republic of Maldives reported 82 confirmed deaths, 26 people missing and more than 3,997 incidents of house/building damage. Such an experience suggests that all atoll nations/districts in the Pacific and Indian Oceans face a potential risk of severe tsunami-induced damage, and an understanding of what occurred may help us to form a basis for recognizing the safer areas of land on atoll islands.

To this end, we investigated 43 islands in the northern-to-southern Maldives by measuring watermarks and profiles across the islands, and interviewing local residents to determine the characteristics of the tsunami and evacuation procedures.

The movement and influence of the tsunami varied by atoll and island topography. In the northern Maldives where the atoll rims consist of numerous faroes and are interrupted by many channels, the tsunami entered the lagoons through these channels and appeared to set-up the lagoon water level. The backwash of the lagoon water to the open ocean caused inundation of the lagoon-side villages on islands at the eastern atoll rim. Beach ridges developed on the eastern side of these islands acted as breakwaters against the tsunami from the east. In contrast, catastrophic damage and high run-up levels of 3.6 m above Mean Sea Level at maximum water depth occurred on the eastern islands in atolls with a continuous atoll rim in the southern Maldives. Damage on the western atoll rims and in the lagoons was relatively small. The continuous eastern atoll rim and its islands acted as a breakwater against the tsunami from the east. The eastern islands in atolls in the central Maldives where the atoll rim is moderately interrupted by channels were hit by both the direct surge from the east and floodwater from the lagoon. Less damage was reported from the far southern atolls where major channels cut across the atoll chain.

The movement of the tsunami in atolls thus differed according to the distribution of the atolls in the archipelago and the continuity of atoll rims against the incoming direction of the tsunami. The disaster status on individual islands also differed according to the location of islands on atolls, height of islands, and development of beach ridges and associated topographic zones.

It is generally understood that the Indian Ocean tsunami arrived without any forerunning phenomena in areas located west of tsunami source area. However, according to the results of our interviews in the southern Maldives, the following forerunning phenomena were in fact observed: 1) loud noises (from 2-to-10 minutes before the tsunami); 2) bubbling reef flat water (from 2-to-10 minutes before the tsunami); and 3) the thrusting up of house floors (a few-to-10 seconds before the maximum tsunami surge). Refuge taken in branched trees and in the lee of strong walls was especially effective on low-lying atoll islands. Fishing boats (dhonis) played an important role in the rescue of people swept into lagoons. It is hoped that the collation of detailed information on the December 2004 tsunami events and disaster measures taken in this report will contribute to a better understanding of the risks faced by atoll nations, as well as to risk management development.