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Natural Barriers to Natural Disasters

ALEXANDER M. KERR AND ANDREW H. BAIRD

Coastal forests, according to various reports, ameliorated the death toll and damage caused by the December 2004 tsunami in the Indian Ocean. Many organizations have therefore advocated the replanting of forests as a natural barrier against tsunamis. For example, the World Conservation Union (IUCN) is promoting "Mangroves for the Future," a $62 million program that aims to build natural barriers of mangroves in 12 countries in Asia and Africa. Discussions to date within the conservation community have concentrated on how to make these replanting programs successful. A far more important consideration, however, is whether or not these barriers will be effective against future tsunamis.

The science upon which these coastal reforestation projects are based is unconvincing; nearly all of the primary accounts supporting a mitigating role for vegetation during the 2004 tsunami are anecdotal. Quantitative support for the mitigation hypothesis has been mixed. For example, Danielsen and colleagues (2005) concluded that coastal forests in Tamil Nadu, India, attenuated tsunami-induced waves and protected shorelines against damage. However, a reanalysis of data from the same area (Kerr et al. 2006) found no relationship between human mortality and the extent of forests fronting coastal hamlets when controlling for differences in elevation and distance from shore—not surprisingly, more vegetation can front a hamlet lying farther inland than one adjacent to the coast. Furthermore, more recent work, including data from 57 sites throughout the Indian Ocean, concluded that the distance the tsunami penetrated was best explained by distance from the earthquake epicenter—that is, wave height at the coast—and features of nearshore bathymetry (Chatenoux and Peduzzi 2007). Most important, coastal vegetation had no mitigating effect on inundation distance. We do not argue that such an effect does not exist; more data and more powerful approaches may well find an association. Certainly, the protection afforded by a shoreline of dense trees appears substantial for typical storm-generated waves (Massel et al. 1999); however, it decreases monotonically with increasing wave energy. For example, the tsunami following the 1883 eruption of Krakatoa penetrated 8 kilometers of full-canopy rainforest (Simkin and Fiske 1983).



View looking northwest from the bridge in the village of Lhoknga, Aceh, Indonesia. Top: November 2000. Bottom: March 2005. Almost all coastal vegetation up to 4 kilometers inland was destroyed by the tsunami of 26 December 2004.

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This lack of quantitative support for the mitigation hypothesis has not dampened the enthusiasm with which environmental organizations, governments, and some scientists are promoting the efficacy of "green belts" and "buffer zones" in averting future catastrophes. Government enforcement of these buffer zones is a cause of major social injustice involving the eviction of people from the coast and the failure to provide financial support for those wishing to rebuild their homes within these zones (*www.tourismconcern.org.uk/pdfs/Final%20report.pdf*). We are concerned that promoting green belts as barriers, particularly in preference to tsunami early-warning systems, as suggested by some scientists (e.g., Dahdouh-Guebas et al. 2005), may lead to substantial loss of life in a future event. As we argue above, these barriers have yet to be proven effective, and therefore may encourage a false sense of security.

Consequently, these schemes direct time and money away from more effective measures, such as well-coordinated early-warning systems, community education, and emergency planning. Incredibly, more than 18 months after the Indian Ocean tsunami, the Indonesian government has yet to deploy an early-warning system south of Sumatra. The tsunami of 17 July 2006 in Java demonstrated the tragic consequences of this oversight. Tremors from the earthquake that preceded the tsunami were felt, and the trough of the tsunami reached the coast before the crest, causing a telltale drawdown (a seeming drop in the sea level), yet many people did not think to run. Government officials were given precise warnings of the likelihood of the tsunami and failed to act. Clearly, education efforts in Indonesia have been inadequate.

Coastal vegetation, such as mangroves, can provide coastal communities with many valuable goods and services, and the protection and rehabilitation of these ecosystems is an endeavor we wholeheartedly support. However, in the absence of adequate studies, the significance of vegetation in ameliorating mortality and damage from future tsunamis remains an open question, and thus any role the hypothesis plays in environmental advocacy and in formulating policy could prove disastrous.



View looking south over the villages of Lhoknga and Lampuuk Aceh, Indonesia. Top: November 1987. Bottom: December 2005. Almost all coastal vegetation was stripped away by the tsunami of 26 December 2004, and every structure in both villages was entirely destroyed, with the exception of the mosque (not visible).

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