THE AUSTRALIA INSTITUTE

The Indian Ocean Tsunami and Sea Level Rise

Lessons to be Learned

There has been much recent discussion in the media concerning both the tragic events in the Indian Ocean and sea level rise associated with global warming. They are of course not directly linked, but there are important lessons to be learned from the tsunami for coping with long-term sea level rise, especially in low-lying regions in the Indian and Pacific Oceans.

One obvious difference between a tsunami and global sea level rise is the duration of the events. The Indian Ocean tsunami travelled from its source (an earthquake off Sumatra) to most of the regions it devastated in under three hours. The effect on those living on the shore was even more rapid - they had only minutes to react to the oncoming waves. In comparison, the effects of climate change are much slower - significant changes only happen over decades. However, probably the most important difference is that, while a tsunami dies down completely in a day or two, sea level rise will be with us for many centuries.

Tsunamis may also be much higher than the sea level rise that we expect to occur during the present century. While the Indian Ocean tsunami was only a metre or so in height as it travelled across the oceans,[1] there are reports of it being amplified to many metres by the time it reached the land. On the other hand, the Intergovernmental Panel on Climate Change has estimated that the global sea level will rise by 0.1- 0.9 of a metre by 2100, relative to the level in 1990.[2] Although even the higher of these estimates may sound small, the effect on communities living on low-lying coastal land would be devastating as 100 million people live within about one metre of the present sea level.[3]

It is instructive to look at two regions that have previously received considerable attention regarding the effects of future sea level rise: Bangladesh and the Maldives.

The populous low-lying land of the deltaic regions of Bangladesh will suffer severely from sea level rise – it has been estimated that a 1.5 metre rise in sea level would affect 17 million people.[4] So why was the impact of the recent tsunami on this country so small? There are a number of reasons. Firstly, the wave that propagated northwards to Bangladesh appears to have been weaker,[5] possibly due to the shape of the original

[1] http://www.pmel.noaa.gov/tsunami/tidegauge200441226.html (Maldives); http://www.noaanews.noaa.gov/stories2004/s2358.htm (Cocos Islands)
[2] http://www.grida.no/climate/ipcc_tar/wg1
[3] http://www.marine.csiro.au/LeafletsFolder/45slevel/45.html
[4] http://www.grida.no/climate/vital/33.htm
[5] http://www.ppk.itb.ac.id/aceh/simulasi_tsunami_aceh.htm

earthquake zone.[6] Secondly, much of the energy of the arriving tsunami was dissipated in the large expanse of relatively shallow water offshore,[7] and thirdly, prior to the tsunami some 2000 multi-storied shelters had been installed to protect the population from cyclones and storm surges.[8] Of course, none of these factors will be any protection against the impending sea level rise due to global warming.

The Maldives, on the other hand, suffered substantial damage and loss of life (around 70 people perished and 11,000 were displaced).[9] The height of the tsunami was about 1 metre[10] while 80% of the Maldives are less that one metre above normal sea level[11] and the highest point is only 2.4 metres above sea level.[12] The resulting devastation gives us a much better appreciation of the probable effects of sea level rise on such low-lying coastal communities.

While we can learn a little about the likely effects of sea level rise from the tragic events of the past weeks, there is another vitally important message that should not be overlooked - that these events offer a unique opportunity. The tsunami has cleared much of the infrastructure from regions threatened by future sea level rise. Rebuilding of this infrastructure will need to proceed speedily in order for the many displaced people to return to more normal lives. There is a danger that redevelopment will occur on the same sites, with any future tsunami risk being accommodated through a combination of a warning system and a network of disaster shelters.

It is, however, of the utmost importance that any rebuilding takes account of expected future sea level rise.

Sea-level rise has two effects on a shoreline. On a hard (e.g. rocky) shore, the water surface simply moves up the sloping beach. However, on sandy shorelines, the beach and dune system is actually eroded, causing additional shoreline retreat. In the first case, the position of the new shoreline may be estimated simply from the rise in sea level, while the second case is far more complicated and requires knowledge of the way in which the coastal morphology responds. A crude rule of thumb is that, for every centimetre of sea level rise, the shoreline retreats by one metre.[13]

Once these processes are reasonably well understood, a sound strategy is that of managed retreat, whereby development is restricted within a certain distance of the present shoreline, determined by the expected shoreline movement during the life of the structure.[14] These set-backs may be supplemented by density restrictions and 'rolling easements' that allow development to be pushed back as sea levels rise. Already some developed and developing countries have adopted such policies including no-build zones and set-backs of 50 metres or more.

---

[6] http://earthobservatory.nasa.gov/NaturalHazards/shownh.php3?img_id=12646
[7] http://independent-bangladesh.com/news/jan/01/01012005mt.htm#A5
[8] http://www.guardian.co.uk/worldlatest/story/0,1280,-4703411,00.html
[9] http://en.wikipedia.org/wiki/2004_Indian_Ocean_Earthquake
[10] http://www.pmel.noaa.gov/tsunami/tidegauge200441226.html
[11] http://www.environment.gov.mv/climate.htm
[12] http://www.gesource.ac.uk/worldguide/html/950_map.html
[13] http://www.physicstoday.org/pt/vol-57/iss-2/p24.html
[14] http://www.grida.no/climate/ipcc_tar/wg2/301.htm#663

The tragic events of the past week therefore offer the opportunity for large coastal regions in and around the Indian Ocean to be redeveloped in a way that affords appropriate protection from sea level rise during the coming centuries. A wide range of expertise is required for this, including sea level scientists, geomorphologists, risk analysts and coastal planners - some of whom could and should be provided by the region's richer neighbours.

7 January 2005

The Australia Institute
Innovations Building
Australian National University
Canberra, ACT, 0200
www.tai.org.au
exec@tai.org.au
(61) (2) 6125 1270