CASE STUDY 1:

Tsunami Warning and Mitigation for the Indian Ocean Region

Image 1: The 11th March 2011 Tohoku tsunami striking the eastern coast of Japan.
Source: Newscom/Kyodo/WENN.com.

The Problem

On 26th December 2004, the Indian Ocean was struck by a massive earthquake and tsunami which killed 230,000 people and caused widespread destruction [1]. Although we cannot prevent tsunamis, early warning of their approach combined with physical defences and well-practiced evacuation procedures can save many lives.

Prior to 2004, tsunamis were not considered a high-risk hazard, certainly not outside the Pacific Ocean. Tsunami science was a niche scientific field, with little translation of knowledge into practice, even though scientists published work on a possible ocean-wide tsunami in the Indian Ocean just months before the 2004 event [2]. This combined with rapid population growth of coastal communities in the region set the scene for catastrophic consequences for the Indian Ocean rim in 2004.

The science

The early 1960s saw the development and acceptance of plate tectonic theory, wherein earthquakes and volcanoes were first recognised to be the direct manifestation of the forces that create oceans and build continents [3]. The first global seismographic network was established in 1961 [4], allowing earthquakes to be monitored worldwide.

By the 2000s, great advances had been made in earth observations, computer modelling of hazards and telecommunications. Electronic sensors were developed that could rapidly detect earthquake shaking on land and tsunami waves at sea. For instance, the United States National Oceanic and Atmospheric Administration (NOAA) developed the Deep-Ocean Assessment and Reporting of Tsunamis system, known as DART II, in which a

1 Doocy S, Rofi A, Moodie C, Spring E, Bradley S, Burnham G, Robinson C. Tsunami mortality in Aceh Province, Indonesia. Bulletin of the World Health Organization. 2007; 85(2):273-278.
2 Cummins P, Burbidge D. Small threat, but warning sounded for tsunami research. AusGeo News. 2004; 75:4-7.
3 Dewey JF, Bird JM. Mountain belts and the new global tectonics. Journal of Geophysical Research. 1970; 75(14): 2625-2647.
4 Acoustics and Seismics Laboratory, Institute of Science and Technology, The University of Michigan. Handbook: World-wide Standard Seismograph Network. Ann Arbor:University of Michigan, 1964, pp500.

sensor on the ocean floor detects tsunami waves and communicates these to a surface buoy with satellite telecommunications capability[5] (Figure 1).

Computer models were developed that simulate tsunami impacts on communities[6, 7]; and satellites could now transmit signals to high-speed computers, empowering humans to issue local and pan-oceanic tsunami warnings in minutes[8, 9].

The application to policy and practice

In less than three months following the devastating Indian Ocean tsunami, scientists worked together with policymakers to form an international commitment to develop an Indian Ocean Tsunami Warning & Mitigation System (IOTWS). The IOTWS is now fully operational, comprising a set of Regional Tsunami Service Providers (India, Australia, and Indonesia) issuing tsunami advisories to all National Tsunami Warning Centres of the Indian Ocean rim countries[10].The IOTWS also developed the first international guidelines for tsunami hazard and risk assessment[11].

The most heavily affected nations of Indonesia, Sri Lanka and India developed new disaster management policy frameworks, governance structures and national disaster management plans to address tsunami and other natural disaster risks. For instance, the Indonesian Government developed the Presidential Tsunami Master Plan for Reducing Tsunami Risk[12], which is underpinned by national-scale tsunami hazard mapping to establish tsunami shelters and strengthen warning systems for at risk coastal communities.

Did it make a difference?

The IOTWS now provides warnings to all Indian Ocean country members, reaching millions of people who had no warnings in 2004. Furthermore, tsunami hazard mapping and evacuation planning has been carried out for hundreds of coastal communities.

Gains in tsunami preparedness were demonstrated during the 12 April 2012 magnitude 8.5 earthquake offshore of northern Sumatra, Indonesia. Although no tsunami eventuated, due to the large magnitude and location, a tsunami warning was issued in several countries. In Banda Aceh, where most of the tsunami-related deaths occurred in 2004, over 75% of the population started to evacuate soon after the earthquake[13]. Despite this, traffic jams slowed the evacuation considerably[14], demonstrating that challenges still remain in getting dense populations to safety within very short warning timeframes.

Meanwhile, the 2011 Tohoku tsunami severely tested Japan's highly advanced warning system, seawalls and evacuation plans (Image 1). Tragically 18,000 people lost their lives[15], totalling 4% of the population located in the inundation area. In comparison, the 2004 Indian Ocean Tsunami resulted in over 20% fatalities in the inundation area[16]. While any fatalities are shocking, it is clear that the application of science and technology can save lives.

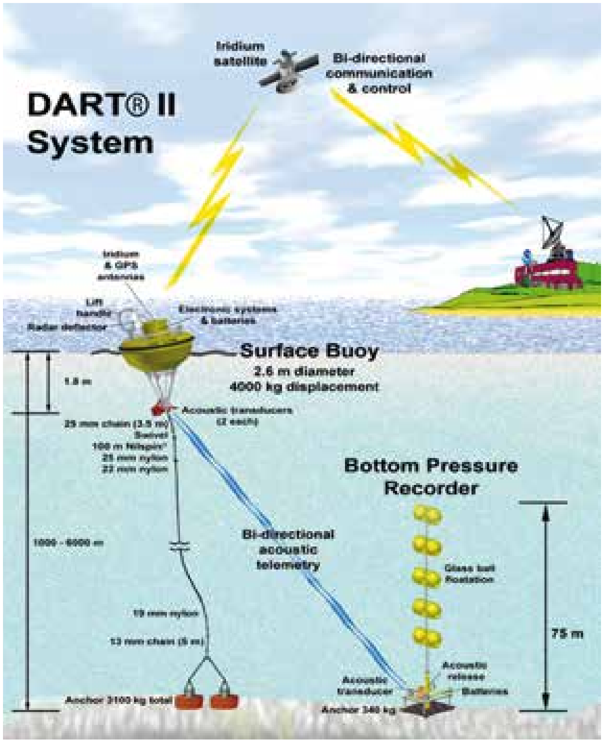

Figure 1: Overview of the DART II System for tsunami detection. *Source: National Oceanic and Atmospheric Administration*[17].

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14 *Ibid.*

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17 National Oceanic and Atmospheric Administration (NOAA). DART II System. Available at: http://www.ndbc.noaa.gov/dart/dart.shtml [accessed 29 April 2013]