Tsunami – is Australia prepared?

by Michael Paine

The January issue of Engineers Australia had a concise review of tsunami warning systems by Bob Jackson. He mentioned recent work by Geosciences Australia that modelled the 1833 Sumatran earthquake tsunami and the threat to the West Australian coast.

While the West Australian coast is the most likely to be struck by a major tsunami, it is also appropriate to look at the consequences of such an event when considering risk management measures. When this is done the eastern seaboard of Australia may well be the most vulnerable. I looked at this issue in 1998, as it happens just a few weeks before the devastating New Guinea tsunami, while researching the consequences of ocean impacts by asteroids (the outcome of that research was published in the Science of Tsunami Hazards in 1999).

Ted Bryant, an Associate Professor at the University of Wollongong in Australia has been studying tsunami since 1989, when he and colleagues first came to the radical conclusion that a "mega-tsunami" some 500 years ago was responsible for a range of strange geological features along the southern New South Wales coast. He eventually wrote a text book with the portent title "Tsunami - the underrated hazard". The summary states "Between 1990 and 2000 over ten major tsunami events have impacted on the world's coastlines, causing devastation and loss of life. Evidence for past great tsunami, or 'mega-tsunami', has also recently been discovered along apparently aseismic and protected coastlines. With a large proportion of the world's population living on the coastline, the threat from tsunami cannot be ignored."

The book documents the many devastating tsunami that have struck in historical times (see maps). Bryant notes that, so far, only coastlines of the South Atlantic lack evidence of significant tsunami. Tsunami in the Pacific Ocean alone have caused over 460,000 fatalities.

The destructive power of a major tsunami, as described in Bryant's book, is demonstrated in the before and after satellite photographs of the towns devastated in the Indian Ocean tsunami. Sealed roads have been destroyed, reinforced concrete bridges ripped apart, train carriages washed hundreds of metres and coastlines radically altered. This should be cause for critics of Bryant’s work to review the convergence of evidence for which the best explanation is that a mega-tsunami struck the south east Australian coast around 1500AD.

Dr Vic Baker from the University of Arizona studies catastrophic flood erosion on Mars and has compared them with the strange landforms of the Washington Scablands in the USA. Early in 2002 I contacted Dr Baker by email and, to my surprise, he told me he would be visiting Dr Bryant in Wollongong the following

week. A quick call to Dr Bryant confirmed that I could tag along while Dr Baker was shown the tsunami signatures of the area.

The northern side of Bass Point, just south of Shellharbour, is covered by a thick, jumbled layer of sand, crushed shells, pebbles and boulders - clearly subjected to severe mechanical action. The explanation is that they have been dumped there when a mega-tsunami swept over the headland from the south east. We then crossed to the rugged, exposed south east face of the headland. Here, carved into the rock, are two giant donut-shaped whirlpool features some 50 metres across. One is complete and has a central plug (Figure 1). The other is about three-quarters complete and looks as if a it was being quarried when work suddenly ceased (Figure 2). Bryant's explanation is that when the tsunami overwashed the headland giant whirlpools were formed. The outer edges of the whirlpool started to form secondary vortices ("kolks") that were highly erosional and tore out chunks of bedrock in a circular path. In one case the tsunami finished before the full circle could be completed.

There are several other examples of these giant erosional whirlpools in the Wollongong area, each in a different type of rock and with no apparent correlation with weaknesses in the rock.

We clambered over the rock formations at Bass Point to a valley that had a group of boulders at one end. The boulders were imbricated (stacked like a pile of fallen dominoes). He explained that the boulders had been carried from the seaward side of a ridge that was more than six metres above sea level. He pointed out that one of the boulders had oyster shells attached - it had been scooped up from the shoreline by a tsunami, carried over the top of the ridge and dumped against the other boulders (Figures 3 and 4). The shells had been dated to 1500AD. Bryant cautioned that, by itself, dating shells was not reliable but other tsunami signatures along the coast had been dated, by more reliable methods, to the same period.

After Bass Point we travelled to several spots along the south coast to see other examples of catastrophic erosion, imbricated boulders and anomalous sand deposits in odd places. Dr Baker agreed that a mega-tsunami was the best explanation for these features.

Quantifying the threat to Australia

In 1999 I pointed out the need to learn more about the risk to Australia's coastline from major tsunami and recommended that a working group be formed to:

* Develop a project plan for tsunami research and mitigation

* Provide technical and operational advice and oversee the implementation of the plan

* Conduct further research into geological evidence of tsunami along the Australian coastline

* Conduct further research into archaeological and historical evidence of tsunami affecting coastal Aboriginal populations.

* Liaise with international experts on the vulnerability of the Australian coastline to tsunami

* Arrange computer simulations to determine the likely effects of tsunami on various parts of the Australian coast

* Review tsunami warning and mitigation systems in place in Japan and the West Coast of North America.

* Develop a proposal to implement an appropriate tsunami warning and mitgation systems in Australia.

(Extract from "Australian Spaceguard Survey: the Australian component of an international effort to detect Earth-threatening asteroids and comets" - May 1999).

Some of these recommendations have since been partially implemented (not necessarily in response to the report) but no effective warning and *response* system is in place for vulnerable locations like Sydney, Newcastle and Wollongong. In a 1999 paper published in the Science of Tsunami Hazards, Jack Rynn from Australian Center for Earthquake Research and Jim Davidson from the Bureau of Meteorology, pointed out that the coastline between Wollongong, Sydney and Newcastle likely has both a high hazard and a high vulnerability to tsunami. It is rated as having one of the highest tsunami risks in Australia.

So are we prepared?

In 1989 the Newcastle/Sydney region experienced a mild earthquake and 15 people died when a building collapsed in Newcastle. Following analysis of the 1998 New Guinea tsunami, it is now apparent that "mild" earthquakes can set off undersea landslides on nearby continental shelves that, in turn, generate deadly localised tsunami. Maybe after thorough seafloor surveys have been conducted and analysed for landslide potential then some coastal areas can be declared 'safe" from such short-range tsunami. In the meantime it would be prudent for people on coastlines with steep continental slopes (like Sydney) to quickly move to higher ground if they feel an earthquake, just in case such a landslide tsunami is generated.

Australia now participates in the Pacific tsunami warning system and receives the warning broadcasts. However, as the recent tragic experience in India shows, such warnings need to be quickly acted on and people alerted, if necessary. Coastal communities need to be educated about reacting to an alarm, or to other signs, such as local earthquakes or sudden drops in sea water levels.

Very simple education can be effective - the Economist reports that people in Vanuatu were shown videos of the devastating New Guinea tsunami of July 1998. Only five people died when a tsunami struck Vanuatu one year later.

About the author

Michael Paine is a Mechanical Engineer. He lives on the Northern Beaches of Sydney – an area identified by CSIRO as one of the most vulnerable stretches of the Australian coastline for sea level rise. Michael first became interested in tsunami after learning that an asteroid impact may have caused a mega-tsunami along the New South Wales coast just 500 years ago. His 1974 engineering thesis included creating a small tsunami-like wave in a flume tank for experimenting with model surfboards.

Michael is a Member of Engineers Australia and a Member of the Tsunami Society.