

Tsunami

The PNG event of July 1998

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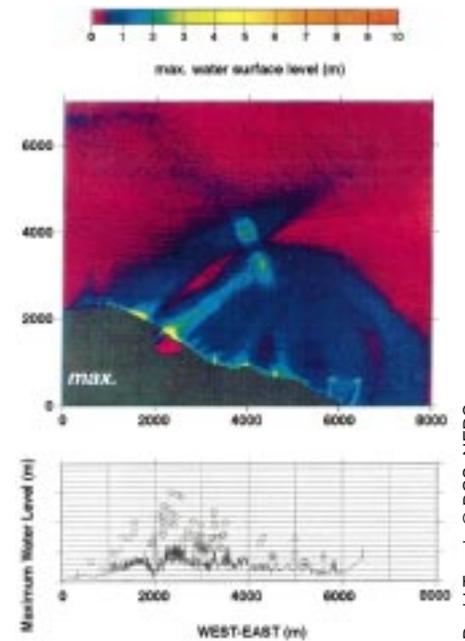
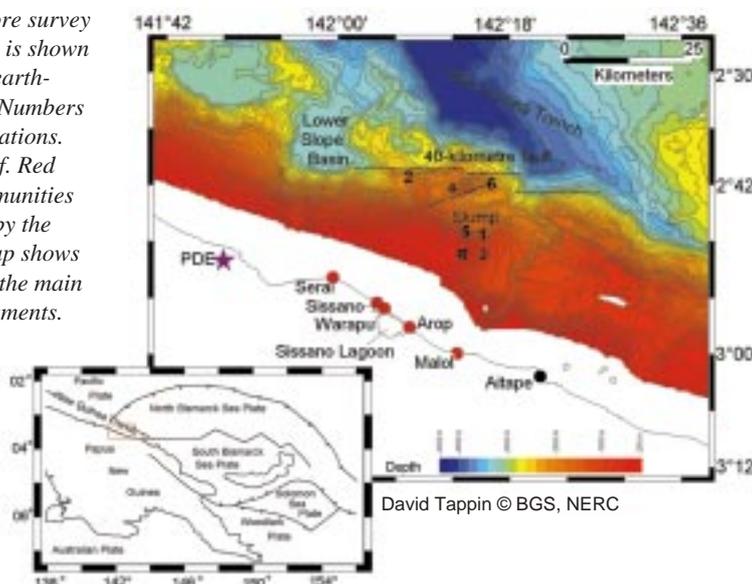
Tsunami, often inaccurately termed tidal waves, are a surprisingly common phenomena. Since 1990 there have been 82 tsunami reported globally, with ten taking more than 4000 lives. The devastating tsunami that struck the northern coast of Papua New Guinea (PNG) on 17th July 1998 claimed 2200 lives as mountainous waves up to 15 metres high completely destroyed three villages and severely damaged four others. With such a loss of life there was an immediate response from the scientific community. For the first time there was a comprehensive investigation that included onland study, offshore sea bed imaging, geological interpretation and computer simulation. Two offshore surveys, acquiring sea bed bathymetry and visual images were carried out very soon after the event.

Until recently, tsunami studies had mainly focused on transoceanic tsunami where the source is far distant and warning times of up to 24 hours are practicable. However,

there has been an increasing recognition that locally sourced tsunami, such as the PNG event may be as frequent and as devastating as these 'far-field' events. Warning times for tsunami generated locally may be only minutes, thus different mitigation strategies have to be developed.

Most tsunami are the direct result of seafloor displacements caused by major earthquakes. However, for the PNG event the earthquake magnitude (~7) was too low and the earthquake not of the right type to produce such large waves. Initial computer simulations of a fault source also failed to recreate the wave heights and distribution along the coast. A major constraint on the simulations was the lack of detailed seabed bathymetry data — it is well known that seabed morphology has a critical influence on focusing the tsunami wave. An alternative tsunami source mechanism considered was an offshore sediment slump created by the shaking effect of the earthquake.

Map of the offshore survey area. Bathymetry is shown offshore. Star is earthquake epicentre. Numbers are ROV dive locations. R = Subsided reef. Red dots are the communities most devastated by the tsunami. Inset map shows the survey area with the main plate tectonic segments.



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Upper: the maximum water level surface of a tsunami generated from the sediment slump. Lower: a comparison of measured water levels on the coast (circles) with computed water levels (line) at the 10m contour derived from a tsunami originating from the location of the sediment slump. (Note: The difference between the measured and computed water levels is due to an overly conservative estimate of the initial slump shape and motion. Water depths between the coast and 200m are interpolated.)

With the acquisition of offshore data, discrimination was made possible between a coseismic and a sediment slump tsunami source. 25 kilometres offshore of the most affected area a sea bed feature was identified that closely resembles a slump. Visual evidence (fissures, breccias, talus slopes and headwall collapse) from a Remotely Operated Vehicle (ROV) indicates recent movement of the sea bed in this area. With the new detailed bathymetry, improved computer simulations now reflect the true wave distribution along the coast. Verbal evidence from survivors on the relative timing between the felt earthquake, thought to have triggered the slump, and the arrival of the tsunami waves at the coast indicates that a slump is the most likely cause of the event. On the basis of these new data, mitigation strategies that will protect life and property are being developed.

The figures are based upon Tappin et al., in press. Offshore surveys identify slump as likely cause of devastating Papua New Guinea Tsunami 1998. *Eos Transactions. AGU.*