

ABSTRACT

The development of the Australian Tsunami Warning System (ATWS) was in recognition of the fact that the Australian coastline faces some 8000 km of active tectonic plate boundary capable of generating a tsunami that could reach Australia in two to four hours. The work reported in this paper complements an earlier questionnaire study (Paton, Frandsen & Johnston 2010) with detailed interview data to inform understanding of respondents' awareness of tsunami risk and their willingness (or lack of) to respond to a rare but possible natural hazard. A belief that no tsunami events had occurred in Australia (at least since colonial times) and that major causes (e.g. seismic and volcanic) were absent, supported the view of participants that tsunami is a non-existent or a very low-probability hazard for Australia. This view was reinforced by the lack of discussion of tsunami by government or in the media. The ensuing sense of 'risk rejection' resulted in respondents believing that no resources or effort should be directed to tsunami risk reduction. The data raises the possibility that the ATWS may not be fully effective unless action is taken to increase tsunami risk acceptance and readiness. Recommendations for doing so draw on participant discussions of how to localise risk reduction activities. Their suggestions for increasing tsunami readiness in coastal communities included integrating it with community-based, localised discussions around frequent flash floods, coastal storms, bushfires and climate change hazards. These concepts are discussed, as well as the use of local volunteer resources to develop preparedness activities.

Community understanding of tsunami risk and warnings in Australia

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Introduction

The Australian coastline includes 8000 km of active tectonic plate boundary capable of generating tsunamis that could impact Australia (Australian Bureau of Meteorology 2008, Attorney-General's Department 2008, Burbidge *et al.* 2008, Dominey-Howes 2007). Australia has experienced over 50 recorded incidents of tsunami since European settlement (Anderson 2015).

Travel times for tsunamis from the closest sources (the Puysegur Trench, south of New Zealand, and the Java Trench, south of Java) are approximately two hours. Allowing for detection and message formation, warning times of as little as 90 minutes can be anticipated. More distant sources have greater travel times and correspondingly longer warning times. Should a tsunami occur, the at-risk population is large. For example, in New South Wales, 330,000 people live at or below a height of 10 metres above sea level and within one kilometre of the coast or a coastal river (Bird & Dominey-Howes 2006).

Recognition of the risk tsunamis pose for coastal communities prompted the development of the ATWS. However, to be effective, people must know about the system and be able to respond in planned and functional ways when a warning is received. It is essential that development of warning systems is complemented with activities that address the capability of people to respond promptly and appropriately when receiving a warning, particularly if warnings only give two hours for plans to be implemented. However, because warning systems have developed faster than community capability to respond to them, a need was identified to develop people's response capability (Bird & Dominey-Howes 2006, Bird & Dominey-Howes, 2008, Dall'Osso *et al.* 2009, Dominey-Howes *et al.* 2007, Gregg *et al.* 2007, Johnston *et al.* 2005, Johnston *et al.* 2009, King & Gurtner 2005, Paton, Frandsen & Johnston 2010). To develop people's capability to respond it is important to examine people's understanding of and beliefs about tsunami and the implications for tsunami risk communication, warnings and preparedness.

Procedure and methods

Participants were recruited through agency websites (e.g. Australian Red Cross, Surf Life Saving Australia, State Emergency Service), email invitations to coastal community groups and via social media channels. A total of 31 interviews were conducted with participants from at-risk coastal areas (e.g. below the 10-metre contour). Data was collected using semi-structured telephone interviews that facilitated an in-depth exploration of the source and nature of participant tsunami knowledge, understanding and beliefs. Interview data was analysed using thematic analysis (Braun & Clark 2002, Guest, MacQueen & Namey 2011).

Findings

Participants reflected that their knowledge of tsunami was limited. Tsunamis were generally described as a large wave event that involved a substantial body of water moving towards land, or hitting the coastline. Tsunamis were characterised as fast-moving and able to travel long distances. Only two respondents acknowledged that tsunamis slow down and increase in height when closer to the shore or when travelling through shallower water.

Participant descriptions of tsunamis as 'destructive' and 'devastating' illustrated that it is hard to conceptualise the levels of destruction that might occur and how helpless people might be. This resulted in participants having fatalistic attitudes about what people could do in the event of a tsunami. Interviewees acknowledged that the risk posed would not be evenly distributed and would be contingent on factors such as the location of the source event (i.e. the earthquake or volcanic event), the size of the tsunami, the geographical characteristics of where they lived and where they were at the time of the event. This knowledge did not, however, translate into acceptance of a need for action on their part.

Participants were unaware of the 50 recorded tsunamis that have reached the Australian coastline in the past 200 years (Anderson 2015). Their lack of knowledge of historical tsunami impacts on communities resulted in participants concluding that tsunami presented no risk or a very low risk in Australia. This view was reinforced by a belief in a lack of causal sources (e.g. sources of seismicity) and by perceptions of a lack of government and media discussion of tsunami risk in Australia.

Some participants conceded that tsunami risk may be greater than realised (a response influenced by this research). Notwithstanding, people's beliefs regarding tsunami risk prompted a collective view that attention should focus on commonly occurring natural hazard events (e.g. bushfire, flood and cyclones) and not on tsunami. These beliefs influenced people's views about warnings and preparedness.

Warnings

Except for a few participants (SES volunteers) who knew of the warning system, no other interviewees knew of the ATWS. Participants were uncertain about how they would receive a tsunami warning and the agency or agencies responsible for issuing tsunami warnings or managing the response. Participants living in bushfire-prone areas identified the police or the fire service as the responsible agency. Some thought that the Bureau of Meteorology would be the lead agency, while others commented that 'something would come up' in internet searches.

Participants had mixed views about how warnings should be disseminated. All participants agreed that warning delivery methods should include TV and radio broadcast communications. Less certainty was expressed about text message warnings, particularly regarding differences in the trustworthiness of the sources. Participants also believed that traditional media would be effective at different times; for example, radio while travelling in the car and TV in the evening.

Other methods, such as sirens on beaches and in public places (e.g. city centres) were raised. Participants discounted these because people often ignore them. Their effectiveness in directing people to evacuate the beach and head inland or vertically evacuate using nearby buildings was doubted. Some interviewees questioned whether warnings could be relayed at all, or in sufficient time. The latter views reflected criticism of the ability of emergency services organisations to get warnings out in time for other hazards (rather than because of potentially short tsunami travel times). Beliefs about tsunami presenting a non-existent risk in Australia had implications for participant views about preparedness.

Preparedness beliefs

A perceived low tsunami risk prompted participants to question the need for resources to be directed to tsunami risk management. This was reinforced by participant views about the effectiveness of preparedness for other hazards (e.g. '...if people aren't prepared for other [more commonly occurring] hazards, why should they do so for tsunami when it's less likely'). Participants did not believe this view would change unless a tsunami event occurred nearby, or there were dramatic changes to the seismic activity around Australia.

Such high levels of risk rejection mean that community engagement disaster risk reduction strategies must first develop some level of risk acceptance before communicating about warnings and preparedness. However, acknowledgement that tsunami risk may be greater than realised prompted suggestions about the content of tsunami warnings.

Anticipated warning content

The first issue identified derived from participant uncertainty about what constituted a safe distance inland or vertically. They expected a warning to inform them about the best course of evacuation action. Time constraints (e.g. if only 90 minutes) to identify where and how to get away were not considered. Furthermore, a warning may not act as a call to action.

Most participants stated that, on receiving a warning, they would first seek verification (e.g. from trusted sources like the ABC, Bureau of Meteorology or by monitoring social media). If local actionable information was included in warnings, they would be less likely to seek verification. After obtaining verification they would contact family and friends to check on their safety and determine if they had received any warnings. Only then would they evacuate themselves. No interviewee considered whether there would be time to do this (e.g. if a tsunami originated in New Zealand waters).

Consistent with this line of thinking, preparedness (e.g. evacuation planning, having a survival kit etc.) was discussed as activities they would do on receiving a warning. The inclusion of actionable information in warning messages was seen as a substitute for pre-event preparedness (though some believed their readiness for hazards like bushfires would be applicable for tsunami).

Participants identified that warnings need to contain several pieces of information. These include:

- what areas were likely to be affected by the tsunami event
- what actions people should take
- how long until the tsunami arrived (at each specific coastal location)

- where to evacuate to (e.g. location of evacuation centres in each area).

At the very least, warnings should direct people to 'get to higher ground'. Participants indicated that such actionable information would guide people's response in the event of a tsunami.

Participants believed that generalised (i.e. region-wide) information would lack local specificity and so hinder action. This prompted suggestions that warnings should include information tailored to specific locations (e.g. local maps, evacuation routes, designated safe places and evacuation centres etc.). No interviewee commented on how this would be accomplished. Developing localised tsunami risk information for every settlement over some 8000 km of coastline would be prohibitively expensive. Some recognition that tsunami may pose a threat prompted discussion about how tsunami risk management may be advanced.

Developing tsunami risk management activities

Participants discussed a need to develop community understanding of tsunami risk through active engagement between agencies and communities. This should focus first on providing detailed information about Australia's tsunami exposure and the implications for preparedness and warnings (e.g. discuss tsunami risk in coastal communities using local maps, the magnitude of events, travel times, warning times etc.). Participants emphasised the need to focus on local implications of tsunami risk. They suggested that planning would be improved by discussions of tsunami risk management with those associated with other regularly occurring coastal and ocean hazards.



Using local maps should be part of community-based planning for a tsunami.

Image: New South Wales State Emergency Service

Discussion and recommendations

Australia has a well-developed tsunami warning system. This study highlighted a lack of community awareness of the ATWS, a high degree of tsunami risk rejection and a lack of specific tsunami hazard preparedness in coastal communities. Participants argued that no effort or resources should be directed to tsunami preparedness. Instead, they suggested that the warning process itself should provide information on local actions and preparedness.

Low warning times makes such an approach untenable. For events with 90 minutes warning time, there would be insufficient time to receive a warning, identify evacuation routes, and decide and act. Additional factors, such as stress while decision-making and traffic congestion might slow people's decisions and actions.

The findings that people reject risk reiterates those from an earlier study (Paton *et al.* 2010, see Figure 1). In the absence of community capability to accept risk and an ability to respond promptly and appropriately on receiving a warning, the effectiveness of the warning system is significantly muted. The findings suggest that the ATWS may not be fully effective without a community risk awareness and readiness program to support it.

Facilitating tsunami warning effectiveness requires effort in developing awareness and risk acceptance. While tsunamis were generally identified as being fast-moving and able to travel long distances, only two respondents acknowledged that tsunamis slow down and increase in height when closer to the shore or travelling through shallower water. Community-based, systematic discussion of tsunami characteristics and behaviours should be included in community engagement programs

run by agencies (e.g. State Emergency Service). Community engagement programs should include information on the source of tsunami warnings and the roles of agencies. Communities should be informed of other sources of information to develop their knowledge and inform their planning. This could include *Tsunami: The ultimate guide* (see Anderson 2015).

Preparedness could be facilitated by integrating tsunami preparedness into an 'all-hazards' process. Participants suggested this could be done by encouraging people to talk about tsunami alongside comparable and other relevant events, such as storm surge education, beach erosion, sea level changes (related to climate change) and bushfires. The short tsunami warning times associated with tsunami events are analogous to a common phenomenon, flash flooding (defined by the Bureau of Meteorology as occurring within six hours of storm rainfall, but often within less than two hours). Integrating tsunami warning response by building on flash flood warnings is an example of a possible all-hazards approach to facilitating tsunami preparedness.

The findings of this study identify a need to counter prevailing levels of risk rejection and develop risk acceptance by increasing community awareness of the existence of tsunami exposure. The existence of fatalistic beliefs stemming from the perceived devastation tsunamis could create makes it important to develop actions people can take to help them deal with tsunami consequences (i.e. develop positive outcome expectancy – see Figure 1).

Community-based, local planning is essential to accommodate the diversity in needs, goals, capabilities and expectations that exist. The use of local maps is an important component of an education strategy. This would involve agencies supporting community initiatives

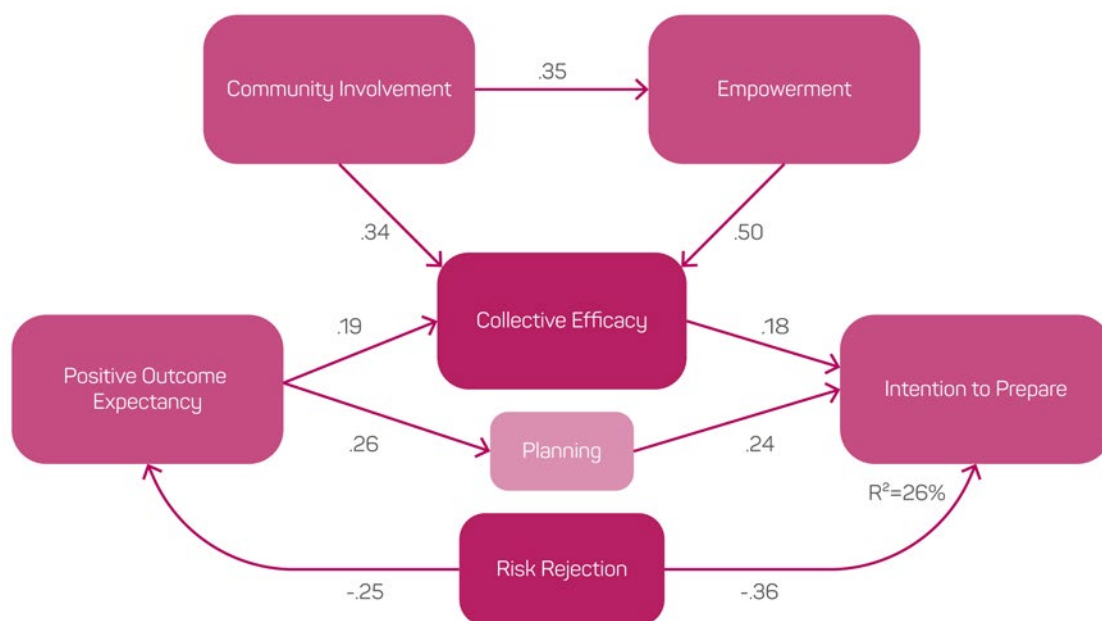


Figure 1. The influence of risk rejection and community engagement in tsunami readiness (adapted from Paton *et al.* 2010).



NSW SES personnel speaking with people about the tsunami risk in their local area.

Image: New South Wales State Emergency Service

rather than developing local plans *per se* (which would be prohibitively expensive). Strategies for doing so could capitalise on work on effective community engagement practices for other hazards (e.g. Paton, Kerstholt & Skinner, in press).

A theme that emerged was that community-based discussions positively influence risk acceptance and preparedness. This is consistent with other findings (Paton, Frandsen & Johnson 2008, Paton *et al.* 2010) that identified that tsunami risk management should be based on community engagement and empowerment strategies.

The findings of this study and those of Paton and colleagues (2010) highlight the value of people discussing tsunami risk and readiness and for agencies (e.g. SES, Surf Life Saving Australia, Coast Care) to work with community members and groups to provide the information and resources they need to advance their planning. Community members should define local needs and appropriate local solutions (develop collective efficacy – Figure 1).

Localised community engagement is an important medium for sharing information between agencies and community groups (Paton *et al.* 2008, Paton *et al.* 2010). While it would be prohibitively expensive to develop local information for all coastal communities around Australia, it may be more cost-effective to engage with local communities and to facilitate their involvement in developing their local knowledge, plans and activities. There is evidence to support the view that strategies that engage people in ways that empower them to identify and deal with local issues (e.g. to mirror the action of the community participation, empowerment and collective efficacy factors shown in Figure 1) can

increase levels of community preparedness (e.g. Paton, Kerstholt & Skinner, in press). This view is reinforced by the finding that, for some participants, the interviews acted as a motivator for developing knowledge of tsunami risk. A key issue here concerns the availability of the human resources required to facilitate the development of local approaches. Agencies such as the SES, Surf Life Saving Australia, Australian Red Cross and Coast Care can draw on a substantial volunteer resource to facilitate this process. The inclusion of several agencies in this process increases the range of groups and community members that can be reached (e.g. while Surf Life Saving Australia may be able to access beach users, the SES and Red Cross may be more effective at targeting others). Employing multiple agencies in this way allows greater opportunities to tailor tsunami risk management information and actions to the needs of diverse groups and community members. If this idea is pursued it will be important to ensure that all agencies provide the same information and adopt comparable community engagement practices to ensure consistency in the core messages provided. It may be beneficial to complement these hands-on approaches with effective communication activities that support community engagement strategies.

Conversations via social media were described as a useful way to support community discussions over time (Dufty 2012, Watson 2012) and facilitate community-based disaster risk reduction activities. The value of doing so is reinforced by findings that social media-based discussions can develop people's sense of community, with the latter contributing to increasing the uptake and use of risk information (e.g. Paton & Irons 2016).

The findings in this paper indicate a general lack of awareness of tsunami risk. This was due to the infrequent nature of major tsunami events and a consequent disregard for any need to manage the associated risk. Tsunami preparedness is essential to realise the benefits afforded by Australia's highly advanced ATWS system.

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