



**SOPAC Member Countries
National Capacity Assessments:
Tsunami Warning and Mitigation Systems**

Republic of Marshall Islands



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SOPAC



1. Results Outline

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1.1. Executive Summary

Relationship of this Project to the Republic of Marshall Islands Disaster Risk Management National Action Plan 2008 – 2018

The Tsunami Capacity Assessment Project contributes to the Republic of Marshall Islands (RMI) Disaster Risk Management National Action Plan 2008 – 2018 (DRM NAP, D1) Action 4.3.1 “Assess the Early Warning System (EWS) capacity and information needs at national and local levels for all key hazards and links to international early warning systems”. This report aims to map to DRM NAP Actions that are anticipated to particularly assist RMI to improve management of the tsunami threat. The report also makes some specific recommendations suggesting improvements in RMI’s tsunami warning and mitigation system.

RMI and development partners are encouraged to consider tsunami in an all hazard approach. This will largely avoid the need to allocate resources to a hazard that is considered low risk in comparison to other hazards faced by RMI.

The Republic of the Marshall Islands (RMI) is comprised of 29 low-lying atolls and five islands of which 24 are inhabited (D1 & D2). Together these atolls form 70 square miles of land. The capital is situated on Majuro atoll in the southeast with a land area of 3.56 square miles. The islands are essentially coral caps, set on underwater dome volcanos rising from the ocean floor and surrounded by 700,000 square miles of ocean (D1). Over two thirds of the nations population of an estimated 57,000 is situated on Majuro and Kwajalein atolls, making these atolls among the most densely populated in the Pacific (D1 & D2).

RMI sea level gauges have detected tsunami events from various sources, the majority of which have been less than approximately 10 cm (4 inches) in amplitude (refer to Figure 4). A 8.1 Mw earthquake on the Kuril trench on the 13th January 2007 resulted in a recorded amplitude at Kwajalein Atoll of 0.11 m (0.36 feet) (NGDC Tsunami Database, 2010). On 15th November 2006 a 8.3 Mw earthquake, again on the Kuril trench, resulted in a recorded amplitude at Uliga (Majuro) of 0.08 m (0.26 feet) (NGDC Tsunami Database, 2010) (Refer to Figure 4). RMI Hazard Mitigation Plan (D4) states that “the incidence of Pacific-wide tsunamis has little affect on the Marshall Islands”. The Plan lists the 9 March 1957, 8 to 8.5 magnitude earthquake in the Aleutian Islands as causing “a minimal 3 meters [tsunami] for Kwajalein and Enewetok”. The Plan also states “of all the tsunamis researched in the last century, no tsunami has registered over 4 meters (May 22, 1960 - Chile 8.25 to 8.85 Earthquake) in RMI”.

RMI is located further from major subduction trenches capable of generating tsunami than many southwest Pacific Island Countries (PICs). The country generally has a greater lead time for warnings and thus appears in a lower hazard category (Pearce, 2008). Atolls can also be somewhat protected as they often have steep drop-offs in which ocean depths increase very rapidly with distance from the fringing reef therefore minimising tsunami shoaling (the process by which tsunami wave heights increase as they approach the shore) and subsequent inundation (Thomas, Burbidge, Cummins, 2007).

However, even relatively small tsunami, particularly when timed with high tides, may have a significant impact on communities on low lying atolls (Pearce, 2008). Even seemingly small changes in sea-level due to tsunami could adversely impact on day-to-day activities in RMI, such as unloading of fuel and water based tourism activities.

RMI is addressing tsunami warning or response capabilities as part of a multi-hazard approach under the DRM NAP (D1), but limited resources for the development of specific tsunami warning and response capabilities, coupled with uncertainties about the tsunami risk limits the extent to which this work has been progressed. Allocation of funding for any hazard group is usually related to level of risk.

The RMI DRM NAP (D1) states that “fortunately RMI is considered to be at low risk to earthquakes, volcanic eruptions and tsunamis”. This risk assessment included in the DRM NAP (D1) is based on the understanding that there is a very low likelihood of tsunami affecting RMI populations based on the lack of any known history of any significant tsunami events. However, RMI acknowledges that the consequences of a significant tsunami event (causing land inundation) could be very high and the country is therefore interested in developing a further understanding of their tsunami risk.

RMI has historically experienced extreme wave action associated with Typhoons as well as “wave trains” thought to most frequently occur due to high tides combined with wind patterns upwind of the islands which establish an unusually long and persistent wave-generating “fetch”. For example, in December 2008 long period swells generated from distant winds over the North Pacific, enhanced by shorter period waves generated locally by tropical depressions led to severe coastal flooding in RMI (Bureau, December 2008). This led to the declaration of a State of Emergency as large amounts of debris and approximately 500 displaced people created sanitation and health concerns in Majuro (UNOCHA Sit Reps, December 2008).

It is important that RMI takes steps now to improve ministry and community response to tsunami warning messages received from the Pacific Tsunami Warning Center (PTWC). The *National Capacity Assessment of Pacific Islands Applied Geoscience Commission (SOPAC) Member Countries: Tsunami Warning and Mitigation Systems* project aims to work in collaboration with the member countries of SOPAC to assess their capacity to receive, communicate and respond effectively to tsunami warnings. The Tsunami Capacity Assessment of the ability of RMI to receive, communicate and effectively respond to tsunami warnings took place in a workshop held from 25 – 28 May 2009 at the Marshall Islands Resort in Majuro.

The workshop was facilitated by a team of visiting experts and attended by some 50 RMI government representatives, community groups and the private sector to discuss key areas of tsunami warning and mitigation in RMI by completing a comprehensive questionnaire in session and via presentations, site visits and meetings.

As well as outlining RMI’s current status, strengths and opportunities for improvement with regard to tsunami warning and mitigation, a list of recommendations were formulated by the Visiting Assessment Team in consultation with national participants. The aim of these recommendations is to guide further capacity development programs to target improvements in RMI’s tsunami warning and mitigation system in the context of the DRM NAP (D1).

The workshop’s resulting recommendations reflected the priorities raised by RMI participants (Refer to Table 3). In addition to implementation of DRM NAP (D1) actions, very high priority recommendations made include:

- Strengthen National Emergency Management Co-ordination Office (NEMCO) staffing and other resources to progress mainstreaming of DRM in all sectors;
- In line with DRM NAP Objective 1.1, progress with the formalisation of the draft set of National DRM arrangements for RMI that was produced and submitted to NEMCO in June 2008. Subsequently progress with the review of legislation and national operational plans for specific hazards based on the formalised arrangements;
- Take advantage of opportunities provided by international and regional partnerships to build national capacity for research expertise in priority areas;
- Develop and include in procedures, a tsunami warning decision making matrix that is pre-agreed by key government stakeholders which outlines what action will be taken for each PTWC message;

- In line with DRM NAP Action 6.2.2, develop a tsunami risk profile for RMI;
- Implement DRM NAP Actions 9.1.1 to 9.3.1 to raise awareness of DRM amongst the public by taking a multi-hazard approach that includes tsunami;
- Strengthen community preparedness and response to disasters using applicable public awareness and education materials that have been adapted for RMI and translated into Marshallese;
- Include tsunami in an all hazards approach to integrating DRM in the school curriculum as per DRM NAP Action 9.3.1; and
- Complete a training needs analysis and development of a national training framework for DRM (including tsunami) in RMI in line with DRM NAP Objectives 1.3.2 and 1.3.3.

RMI workshop participants are encouraged to use this National Tsunami Capacity Assessment report to guide both national projects and aid funded projects to achieve targeted improvements in RMI's tsunami warning and mitigation system. In turn, this will assist in improving systems for other natural hazards. Contingent on the availability of human and financial resources, the Australian Bureau of Meteorology (the Bureau) and project partners will aim to work with potential donors to bring the findings of this project to their attention on a country and regional scale. This will be done in the hope of further capacity development projects being undertaken.

1.2. Recommendations (including priority and resource intensity)

Table 2 outlines the priority and resource intensity for recommendations made to improve RMI's tsunami warning and mitigation system. Both the priority and resource intensity are based on the consensus of the visiting Tsunami Capacity Assessment Team after discussions held within the Tsunami Capacity Assessment Workshop. It is recognised that Table 2 may not reflect the opinions of all individuals involved in the workshop as priorities vary depending on personal responsibilities and areas of interest. Each recommendation is important in its own right to achieve holistic improvements in RMI's tsunami warning and mitigation system.

The priority ranking and resource intensity scale used as a basis for allocating a priority and resource intensity to each recommendation is explained in Table 1. The **Very High priority** recommendations should be seriously considered as requiring urgent completion. **Low resource intensity** recommendations are considered the 'low-hanging fruit' that are achievable with very few additional resources.

Table 1: Priority ranking and resource intensity scale

PRIORITY	RESOURCE INTENSITY
Very High	Low – Recommendation currently being progressed or could possibly be progressed within the capacity of existing in-country resources (funds and staff).
High	Medium – Recommendation could be progressed by existing staff or with a low to moderate number of additional staff and/or expertise and a moderate level of additional in-country funds. May or may not require external funding.
Medium	High – Recommendation would require a high level of additional staff and/or expertise and funds. External funding support is likely to be required.
Low	Very High – Recommendation would require a very high level of additional staff and funds. External funding support will be required.

Table 2: Priority and anticipated resource intensity for completion of recommendations made for improving RMI's tsunami warning and mitigation system.

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 4
Very High	Agencies identified in the DRM NAP to develop their own capacity and readiness to implement respective actions as these form the basis of an effective multi-hazard warning system and mitigation. In particular, encourage agencies identified in the DRM NAP to implement respective actions in consultation with all stakeholders.	Low	Governance & Coordination	Multi-hazard	3
Very High	In line with DRM NAP Objective 1.1, progress with the formalisation of the draft set of National DRM arrangements for RMI that was produced and submitted to NEMCO in June 2008. Subsequently progress with the review of legislation and national operational plans for specific hazards based on the formalised arrangements.	Low	Governance & Coordination	Multi-hazard	5
Very High	RMI to take advantage of opportunities provided by international and regional partnerships to build national capacity for research expertise, in particular with regard to develop a tsunami risk profile for RMI.	Medium	Research Expertise	Multi-hazard	9
Very High	As tsunamis are a short lead time events, develop and include in procedures, a tsunami warning decision making matrix that is pre-agreed by key government stakeholders which outlines what action will be taken (community information and / or warning and evacuation) for each PTWC message received.	Medium	Tsunami Warnings	Tsunami specific	13

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 4
Very High	In line with DRM NAP Action 3.2.1 and 3.3.3, support development, review or endorsement of National Emergency Operations Centre (NEOC) and ministry and private sector emergency response plans and Standard Operating Procedures (SOPs). Promote sharing and awareness of these procedures.	Medium	Tsunami Emergency Response (including evacuation)	Multi-hazard	17
Very High	Through implementation of the Actions under DRM NAP Objectives 6 and 8, consider actions to limit near-shore activities to safeguard and protect the environment, including the preservation of outlying reefs, which may mitigate the impact of tsunami.	Medium	Tsunami Hazard, Vulnerability, Risk and Mitigation	Multi-hazard	26
Very High	Strengthen community preparedness and response to disasters using applicable public awareness and education materials that have been adapted for RMI and translated into Marshallese.	Medium	Knowledge, Information, Public and Stakeholder Awareness and Education	Multi-hazard	30
Very High	Include tsunami in an all hazards approach to integrating DRM in the school curriculum as per DRM NAP Action 9.3.1.	Medium	Knowledge, Information, Public and Stakeholder Awareness and Education	Multi-hazard	32
Very High	Complete of a training needs analysis and development of a national training framework for DRM in RMI (including a training database to track progress) in line with DRM NAP Objectives 1.3.2 and 1.3.3. Tsunami should be included in this multi-hazard training approach.	Medium	Knowledge, Information, Public and Stakeholder Awareness and Education	Multi-hazard	36

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 4
Very High	Strengthen NEMCO staffing and other resources to progress mainstreaming of DRM in all sectors.	High	Governance & Coordination	Multi-hazard	2
Very High	Implement DRM NAP Actions 3.3.1 to 3.3.4, incorporating tsunami into planning, to improve tsunami emergency preparedness and response in RMI.	High	Tsunami Emergency Response (including evacuation)	Multi-hazard	16
Very High	In line with DRM NAP Action 6.2.2, develop a tsunami risk profile for RMI based on tsunami hazard studies completed for the Southwest Pacific Nations to date, tsunami numerical deep ocean modelling carried out by international agencies, research of previous inundation events and Geographic Information System (GIS) data (existing bathymetry and topography). Feed this into DRM NAP Action 6.2.3 to assess coastal hazard and vulnerability.	High	Tsunami Hazard, Vulnerability, Risk and Mitigation	Tsunami specific	22
Very High	Implement DRM NAP Actions 9.1.1 to 9.3.1 to raise awareness of DRM amongst the public by taking a multi-hazard approach that includes tsunami. National agencies to take a lead role in public awareness and education activities at national, local government and community levels, with the support of partners where needed.	High	Knowledge, Information, Public and Stakeholder Awareness and Education	Multi-hazard	27
Very High	Continue to progress a coordinated program of action focusing on key vulnerability and risk issues and on priority gaps by implementation of the DRM NAP to strengthen existing disaster response, preparedness and mitigation processes to embrace a whole of hazard approach to DRM. Use partnerships with technical and development partners to meet capacity needs.	Very High	Governance & Coordination	Multi-hazard	1

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 4
High	Ministry of Foreign Affairs consider RMI becoming a member of Intergovernmental Oceanographic Commission (IOC) to ensure RMI has a voice in determining IOC programs and activities of benefit nationally, as well as benefiting from IOC capacity building in marine science.	Low	Regional & International Coordination	Multi-hazard	7
High	RMI to enhance relationships with international and regional partners in providing access to earthquake and sea level monitoring systems and their data.	Low	Tsunami Monitoring Infrastructure	Tsunami Specific	10
High	Establish regular DRM educational broadcasts by NEMCO representative on radio V7AB.	Low	Knowledge, Information, Public and Stakeholder Awareness and Education	Multi-hazard	29
High	Raise awareness of tsunami warning products and response actions that must be taken for each message type amongst stakeholders and public. This is also relevant across other hazards as per DRM NAP 3.4.1.	Low	Knowledge, Information, Public and Stakeholder Awareness and Education	Tsunami specific	33
High	Consider participation in the Southwest Pacific Tsunami Working Group of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System.	Medium	Regional & International Coordination	Tsunami specific	8
High	Train and equip Majuro WSO for the technical role of sea level monitoring to better analyse the tsunami threat to RMI in real-time.	Medium	Tsunami Monitoring Infrastructure	Tsunami specific	11

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 4
High	Develop local procedures for evaluating and interpreting implications for RMI of PTWC messages using available scientific information (deep ocean tsunami models, sea level data, travel time software etc).	Medium	Tsunami Warnings	Tsunami specific	12
High	Prevent unnecessary public concern and reduce the possibility of false alarms through issuance of "No Threat" advice to the public for tsunami that are not expected to not impact on RMI.	Medium	Tsunami Warnings	Tsunami specific	14
High	<p>Review existing warning systems with a view to develop a disaster communications plan to meet the requirements of the DRM NAP Goal 4 and Act (1987, D3) and improve the interoperability of current communications infrastructure. Include consideration of:</p> <ul style="list-style-type: none"> ○ Various communication technologies and techniques, such as RANET (RAdio and InterNET for the Communication of Hydro-Meteorological Information for Rural Development), Chatty Beetle, EMWIN, RICS (Emergency Managers Weather Information Network) to ensure warnings reach communities on all islands; ○ Training; ○ 24x7 contact; ○ System checks; ○ Back-up options; ○ Ongoing costs; and ○ Maintenance. 	Medium	Communications	Multi-hazard	15

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 4
High	Incorporate evacuation routes and shelters into future plans for all hazards, including tsunami.	Medium	Tsunami Emergency Response (including evacuation)	Multi-hazard	18
High	Review national zoning and building codes based on hazard and risk maps produced in line with DRM NAP Goal 8.	Medium	Tsunami Hazard, Vulnerability, Risk and Mitigation	Multi-hazard	24
High	Including provision of training to the media on the tsunami warning system, how they will receive information and how this information should be communicated to the public. This training program could be delivered in a multi-hazard context.	Medium	Knowledge, Information, Public and Stakeholder Awareness and Education	Multi-hazard	31
High	Strengthen response support to outer islands and preparedness of these communities through consideration in national plans and implementation of DRM NAP Actions 3.5.1 and 3.5.2 (planning, exercising and awareness).	High	Tsunami Emergency Response (including evacuation)	Multi-hazard	20
High	Consider options to improve movement of boats/ships to deep water in the case of a tsunami event. This could potentially involve the expansion of current boat channels and additional boat ramps to improve access to deep water from the lagoons for marine evacuation.	High	Tsunami Emergency Response (including evacuation)	Tsunami specific	21

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 4
High	With international partners, conduct an inventory of available bathymetry and topography data (including that held by internal Government Ministries and Agencies) for RMI. If data is sufficient, conduct tsunami hazard and risk assessments using numerical inundation models of key population and infrastructure areas based on high resolution near-shore and lagoon bathymetric and topographic data noting the unique seabed topography of coral atolls.	Very High	Tsunami Hazard, Vulnerability, Risk and Mitigation	Multi-hazard (data inventory) Tsunami Specific (inundation modelling)	23
High	Commission a study to identify traditional knowledge and its application in DRM (including tsunamis) as per DRM NAP Action 1.4.3.	Medium	Knowledge, Information, Public and Stakeholder Awareness and Education	Multi-hazard	34
High	Develop and deliver a tsunami competency based training program to staff responsible for issuing tsunami warnings for RMI. This training should be developed based on operational SOPs.	High	Knowledge, Information, Public and Stakeholder Awareness and Education	Tsunami specific	35
Medium	Update and check the contact list of national stakeholders that are responsible for tsunami warning and mitigation.	Low	Governance & Coordination	Tsunami specific	4
Medium	Test disaster preparedness and response plans for both distant and locally generated tsunami, including at a national level and involvement in Pacific tsunami exercises. This is in line with DRM NAP Actions 3.3.4 and 3.5.2.	Medium	Tsunami Emergency Response (including evacuation)	Tsunami specific	19

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 4
Medium	<p>To facilitate planning and response, establish a national database to allow storage of and access to DRM information for RMI including:</p> <ul style="list-style-type: none"> ○ Post disaster assessments based on environmental, social, economic and physical impacts with respect to tsunami, typhoons and other disasters. ○ Emergency response resources as outlined in DRM NAP Action 3.3.1. ○ Critical infrastructure and lifeline support facilities. ○ Integration with existing MapServer. 	Medium	Tsunami Hazard, Vulnerability, Risk and Mitigation	Multi-hazard	25
Medium	Consult with and provide copies of national disaster arrangements and the DRM NAP to outer island local governments and communities.	Medium	Knowledge, Information, Public and Stakeholder Awareness and Education	Multi-hazard	28
Medium	Implement DRM NAP Actions 1.4.1 and 1.4.2 to strengthen the capacity of key community groups and Non Government Organisations (NGOs) in RMI.	High	Governance & Coordination	Multi-hazard	6