SOPAC Member Countries National Capacity Assessments:

Tsunami Warning and Mitigation Systems

Republic of Palau

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AUSTRALIA

SOPAC

Section 1

1. Results Outline

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1.1. Executive Summary

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 the Republic of Palau (hereafter referred to as "Palau") to receive, communicate and effectively respond to tsunami warnings took place in a workshop held from 11 – 14 August 2009 in Koror, Palau.

The workshop was facilitated by a team of visiting experts and attended by some fifty Palauan Government agency representatives, Non-Government Organisations (NGOs), regional and international organisations and the private sector to discuss key areas of tsunami warning and mitigation in Palau by completing a comprehensive questionnaire in session, presentations and site visits.

As well as outlining Palau'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 ongoing improvements in Palau's tsunami warning and mitigation system.

Palau's draft Palau National Disaster Risk Management Framework (NDRMF, D2, 2009) lists tsunami as a low level risk under the natural hazards profile. A number of small tsunami events (generally less than 10 cm in amplitude) have been recorded in the past on Palau's third party sea level gauges at Pohnpei, Malakal and Yap. The main tsunami threat sources to Palau are the Philippines and New Guinea trenches. Palau needs to be aware that short travel times from these nearby sources (of 1 to 1.5 hours) translate to only 30 to 50 minutes of time to warn the community to take appropriate action in the event of a tsunami.

Due to the physical nature of the island group Palau, is not under a great tsunami threat. However, there are some specific considerations for the country. Low lying farming land has been flooded during king tides in the past. These, and similar low-lying areas, are vulnerable to tsunami. The isolation of Palau's southern island States also greatly increases their vulnerability. Finally, Palau's economy is highly dependent on tourism. In addition to Palau's coastal way of life, much of this tourism relates to water activities such as diving and snorkelling. Typically, significant currents are associated with tsunami, even for small events. Local currents may be two or three times greater than those experienced under normal conditions. This should be taken into consideration when assessing the risk of small events to marine activities. People in the water during a tsunami are at significant risk due high currents associated with even small tsunami.

Palau's National Disaster Plan (1998, D1) exists and is in the final stages of being reviewed and replaced by the draft NDRMF (D2). The current 1998 plan is legislated by Executive Order No. 166-99. However, tsunami warning roles and responsibilities are not clearly articulated in the 1998 plan and therefore not legislated. State level disaster plans exist across Palau's 16 States. These too are lacking in inclusions specific to the hazards experienced by that community. Currently, a tsunami response, evacuation and recovery plan does not exist. Palau is progressing Disaster Risk Management (DRM) nationally in an all-hazards framework. Between 2010 and 2012, Palau will undertake a DRM National Action Planning process (supported by SOPAC under the Africa Caribbean Pacific – European Union (ACP-EU) National Disaster Facility) to guide strategic planning effort in the short to medium term.

Palau has limited in-country research currently being undertaken to further develop the country's ability to manage natural disasters, including tsunami. However, a number of government agencies and NGO's in-country (particularly those currently working in environmental conservation of Palau's unique marine environment) have demonstrated capacity to develop their skills in this area. Further use of available scientific tools would enable Palau to make a more accurate interpretation of the tsunami threat to their country after advice is received from international warning centres.

The 24/7 Palau National Weather Service (NWS), which is supported by United States of America's National Oceanic and Atmospheric Administration (USA NOAA) and receives international tsunami messages primarily from the Pacific Tsunami Warning Centre (PTWC) as well as the Guam and Honolulu NWS Offices. Japan Meteorological Agency (JMA) and Alaska Tsunami Warning Centre (ATWC) tsunami messages are received but generally not used. Messages are received through e-mail, fax, Emergency Managers Weather Information Network (EMWIN), Aeronautical Information System Replacement (AISR) (which has an audio alert) and through the internet via the Palau National Communication Corporation (PNCC). Currently, national warnings are issued by the National Emergency Management Office (NEMO) (who are not 24/7), after receiving advice from the NWS. If the tsunami threat is verified NEMO coordinates with the NEC and the President's office to approve Palau tsunami warning messages (including evacuation). The President activates the NEOC with NEMO assistance.

Processes currently exist for dissemination of tsunami warnings nationally. However, these processes are lengthy and complex, which could lead to a delay in issuing effective advice to the community. Palau has three sea level gauges and one seismic station in-country (installed by third parties). This data is not currently incorporated into Palau's tsunami warning processes.

Participants in the workshop stated a number of priority areas for improvement that need to be addressed. Recurring themes included improved emergency response planning, enhancement of tsunami awareness in the community, enhancement of communications systems and identification of communities and groups at risk from tsunami. The workshop's resulting recommendations reflected these priorities. Very high priority recommendations made include:

- Approve, adopt and implement the draft Palau NDRMF (D2) and progress towards incorporating this framework into legislation.
- Each agency and organisation complete a multi-hazard DRM plan which considers tsunami (fast onset hazards) in line with their responsibilities outlined in the National Disaster Plan (1998, D1) and revised NDRMF when approved (D2).
- On formal approval of the NDRMF (D2) develop a Palau National Tsunami Response Sub-Plan to clearly articulate Prevention, Preparedness, Response and Recovery (PPRR) for tsunami on a national level including mitigation, warning, response and regular testing of the system.
- Enhance the NEC to ensure a multi-stakeholder forum exists to address DRM in a multi-hazard context.
- All agencies with key roles to play in the tsunami warning and mitigation systems are adequately resourced to carry out their nominated functions under the National Disaster Plan (1998, D1) (and revised framework when approved, D2).
- That the full authority and responsibility for analysing and interpreting tsunami messages, tsunami data, and sending out tsunami warnings for Palau is formally delegated to the Palau NWS Office based on a pre-agreed warning matrix.
- Develop, approve, share and maintain national tsunami warning and response Standard Operating Procedures (SOPs) for each agency involved in the tsunami warning and response process.
- Improve redundancy in warning communication and improve communication mechanisms to the remote Southwest Islands, including training and education for effective use and maintenance of systems.

- Completion of outstanding State Disaster Plans and enhancement of existing plans to include consideration of tsunami.
- Use existing tsunami hazard studies that have been completed for the Southwest Pacific Nations, historical records, Geographic Information System (GIS) data and deep ocean models to identify low-lying communities which may be prone to tsunami impacts from all likely tsunami sources.

Palau 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 Palau's tsunami warning and mitigation system. In turn, this will assist in improving systems for other high priority, slower onset natural hazards.

Contingent on the availability of human and financial resources, the Australian Bureau of Meteorology (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 Palau'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 these rankings 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 Palau'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' which 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 Palau's tsunami warning and mitigation system.

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 5
Very High	Approve, adopt and implement the draft Palau NDRMF (D2) and progress towards incorporating this framework into legislation.	Low	Governance & Coordination	Multi-hazard	1
Very High	That the full authority and responsibility for analysing and interpreting tsunami messages, tsunami data, and sending out tsunami warnings for Palau is formally delegated to the Palau NWS Office. Warning procedures must be pre-agreed and approved by key government stakeholders and include a tsunami warning decision making matrix that outlines what action will be taken for each international tsunami message received by Palau.	Low	Tsunami Warnings	Tsunami specific	14
Very High	Enhance the NEC to ensure a multi-stakeholder forum exists to address DRM in a multi-hazard context. This should include all-hazard Working Groups for different aspects of DRM (for example, prevention, response). Ensure these Working Groups incorporate State and Village representatives, the private sector and other key stakeholders.	Low	Governance & Coordination	Multi-hazard	5
Very High	Each agency and organisation complete a multi-hazard DRM plan which considers tsunami (fast onset hazards) in line with their responsibilities outlined in the National Disaster Plan (1998, D1) and revised NDRMF when approved (D2). Complete in a standard format, in consultation with relevant stakeholders and share when completed.	Medium	Governance & Coordination	Multi-hazard	2

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 5
Very High	On formal approval of the NDRMF develop a Palau National Tsunami Response Sub-Plan to clearly articulate PPRR for tsunami on a national level including mitigation, warning, response and regular testing of the system.	Medium	Governance & Coordination	Tsunami specific	3
Very High	NEMO, NWS, Palau Community College (PCC) and Office of the Palau Automated Land And Information System (PALARIS) work cooperatively with assistance from external technical agencies (such as SOPAC, PTWC, JMA, the Bureau, University of Hawaii and Guam etc.) to develop in-country scientific skills and knowledge of tsunami, other hazards and tools to improve in-country interpretation of international tsunami messages.	Medium (depending on action taken)	Research Expertise	Tsunami specific	10

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 5
Very High	Develop, approve, share and maintain national tsunami warning and response SOPs for each agency involved in the tsunami warning and response process. In particular, for tsunami warnings, these procedures should include: **a.** A comprehensive decision-making process (flow diagram) for the receipt and dissemination of tsunami warnings. **b.** Procedures for what action will be taken in Palau for each type of international tsunami message received from PTWC and others; **c.** Warning templates including "No Tsunami Threat" bulletins, Palau tsunami warnings and cancellations. Such templates must include pre-agreed and approved emergency response action statements to advise the public in affected areas on the action to be taken; **d.** Agreed and regularly maintained distribution lists; **e.** Use of available scientific information (deep ocean tsunami models, coastal and deep ocean sea level data, travel time software) to localise the tsunami threat to Palau. As the warning system matures, progressively move towards developing criteria for identify differing levels of tsunami threat (for example, marine currents only) as well as cancelling a Palau tsunami threat; **f.** A process for issuing tsunami warnings to marine vessels and ports; and **g.** Procedures to carry out regular and ongoing system tests. Consideration of system redundancies, such as a second back-up agency in-country to receive the international tsunami messages.	Medium	Tsunami Warnings	Tsunami specific	15

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 5
Very High	Investigate use of a 'Chatty Beetle' or Rural Internet Connectivity System (RICS) solution as a backup to EMWIN and the PNCC circuits to receive emergency warnings at the critical NWS Office portal in near future. Regular use of systems such as the 'Chatty Beetle' for weather observations ensures community skills are kept current.	Medium	Communications	Multi-hazard	16
Very High	A 24/7 communication link to the remote Southwest Islands is established to disseminate emergency warnings. Recommend 'Chatty Beetle' or solar charged, permanently mounted Iridium handhelds in the MoH Emergency room and/or at the 911 call centre at the Koror Public Safety Office.	Medium	Communications	Multi-hazard	18
Very High	Completion of outstanding State Disaster Plans and enhancement of existing plans to include consideration of tsunami, evacuation for tsunami, formalisation of State Emergency Operations Centres (EOCs) and traditional emergency response mechanisms (for example, the role of Chiefs).	Medium	Tsunami Emergency Response (including evacuation)	Tsunami specific	24
Very High	Use existing tsunami hazard studies that have been completed for the Southwest Pacific Nations, historical records, GIS data and deep ocean models to identify low-lying communities which may be prone to tsunami impacts from all likely tsunami sources. Commence tsunami mitigation, response and evacuation planning using local knowledge.	Medium	Tsunami Hazard, Vulnerability, Risk and Mitigation	Tsunami specific	29

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 5
Very High	All agencies with key roles to play in the tsunami warning and mitigation systems are adequately resourced to carry out their nominated functions under the National Disaster Plan (1998, D1) (and revised framework when approved, D2). In particular, enhancement of NEMO human resources should be considered to allow them to meet their responsibilities.	High	Governance & Coordination	Multi-hazard	6
High	Nationalise international tsunami warnings through the NWS office obtaining access to the data from sea level gauges (coastal and deep ocean) in the region in real-time including training for staff on how to interpret this data and feed this data into operational tsunami SOPs. An immediate short term solution would be to access data via existing web links (The University of Hawaii http://uhslc.soest.hawaii.edu/ or IOC http://www.vliz.be/gauges/). Access to and training in the use of Tide Tool (PTWC developed) should be considered.	Low (internet) to Medium (training needs)	Tsunami Monitoring	Multi-hazard (data can be used for other applications)	12
High	NEMO, NWS Office, Koror Public safety 911 centre or the Ministry of Heath (MoH) emergency room have interface hardware and software installed to send emergency cellular text and Emergency Alert System (EAS) Television (TV) text to disseminate warnings.	Low	Communications	Multi-hazard	17
High	During a natural disaster emergency services may be isolated from parts of the Koror community due to loss of causeways or bridges. It is recommended Koror State Government continue to consider options for mitigating this risk, these may include back-up locations or multi-skilling of emergency services staff.	Low (to High for implementation of strategies)	Tsunami Emergency Response (including evacuation)	Multi-hazard	27

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 5
High	The hospital at Koror is currently vulnerable to a number of natural disaster threats, including tsunami, due to the proximity to the sea, the low-lying nature of the site and the potential for isolation from the rest of the Palau population (damage to causeways). Early stages of planning for a new hospital are progressing. Implementation of these plans is strongly encouraged from a multi-hazard perspective.	Low (to Very High for implementation of actual relocations)	Tsunami Emergency Response (including evacuation)	Multi-hazard	28
High	Incorporate tsunami warning and mitigation into State Disaster Risk Management Planning (either in existing plans or as a hazard specific Sub-Plan) and include planning for Village preparedness and response.	Medium	Governance & Coordination	Tsunami specific	4
High	Review and strengthen the requirements for marine users to have adequate radio communications on boats to ensure effective receipt of tsunami and other hazard warnings. Ensure the upgrade and maintenance of radio systems on Police search and rescue boats.	Medium	Communications	Multi-hazard	22
High	Consideration should be given to development of emergency evacuation zones for tsunami and review of the placement of existing community emergency shelters for their community to ensure safety away from low-lying coastal areas (particularly for the low-lying southern States (for example, Tobi and Sonsorol). Evacuation authority should be incorporated into the revised NDRMF and associated legislation and tsunami evacuation plans incorporated into the Palau Tsunami Sub-Plan and State Plans.	Medium	Tsunami Emergency Response (including evacuation)	Tsunami specific	23

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 5
High	Bureau of Land and Survey with PALARIS complete an inventory of the geospatial data available for tsunami and multi-hazard risk assessments and mapping of populated centres. In addition to low-lying residential and tourist areas this study needs to plot: **a.** Vulnerable infrastructure including schools, hospital, dispensaries (considering the infirmed and elderly); **b.** Critical services including power, water, sewerage and communications; and **c.** Industrial infrastructure and services including oil storage and chemical manufacture and storage.	Medium	Tsunami Hazard, Vulnerability, Risk and Mitigation	Multi-hazard	30

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 5
High	Key Government agencies and NGOs work together to continue to build on the current DRM community awareness programs incorporating tsunami into the multi-hazard program that includes: **a.** A focus on communities at risk where possible; **b.** Agreement on key tsunami education messages for incorporation into all programs (for example, National Science Week); **c.** Continue with the integration of tsunami (and multi-hazard) information into the school curriculum; **d.** Look at opportunities to deliver educational messages about tsunami across a range of mediums (for example, electronic media, brochures and face to face delivery); **e.** Further develop networks with international agencies such as the International Tsunami Information Centre (ITIC) and SOPAC regarding using/adapting existing international materials about tsunami and other hazards; **f.** Review and evaluate awareness programs (through focus group testing, questionaries etc.) to ensure effectiveness of dissemination of information; **g.** Educate the community about how they will receive warning information and what to do; **h.** Ensure a process is designed and employed to educate the tourism industry about key tsunami messages and what to do in the event of a tsunami. The tourism industry can then employ an education process for divers and other visitors;	Medium	Knowledge, Information, Public and Stakeholder Awareness and Education	Tsunami specific	32

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 5
High	Recommendation 32 (Continued) **i.** Awareness about tsunami and other hazards be incorporated into certification and training of marine boat operators, including tour operators; and **j.** Identify and employ methodologies to cater for special needs and non-English speaking groups.	Medium	Knowledge, Information, Public and Stakeholder Awareness and Education	Tsunami specific	32 (Continued)
High	Completion of training needs analysis and development of a national training framework for DRM in Palau (including a training database to track progress). Development of tsunami modelling capability at PALARIS could form part of the identified training needs.	Medium	Knowledge, Information, Public and Stakeholder Awareness and Education	Multi-hazard	35
High	Development of a tsunami competency-based training program for the operational staff of key agencies (NEMO and NWS) to reflect tsunami operational practices as outlined in developed SOPs.	Medium	Knowledge, Information, Public and Stakeholder Awareness and Education	Tsunami specific	36
High	Palau should seek technical assistance to upgrade and maintain the Amplitude Modulated (AM) broadcast station. AM radio signals can deliver disaster related warnings and updates to the Southwest Islands and the northern populations that are out of Frequency Modulated (FM) broadcast station range. Consideration should also be given to the remote trigger of a siren signal to the radio station.	High	Communications	Multi-hazard	19
High	Add Radio Frequency (RF) or cellular triggered (with manual back up) sirens in all States.	High	Communications	Multi-hazard	21

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 5
High	Train remote island communities to be 'primary responders' (for example, island leaders) to disastesr before help arrives. This should include maintenance and use of communications equipment.	High	Knowledge, Information, Public and Stakeholder Awareness and Education	Multi-hazard	37
High	Maintain and upgrade the central and north medical Very High Frequency (VHF) two-way radio network as well as the VHF in the Rock Islands. Consider upgrading to a linked repeater system with full interagency interoperability.	Very High	Communications	Multi-hazard	20
Medium	Key Government agencies work together on a media education and communication strategy that assists the media to understand hazards and warning procedures, forms agreement on approved media platforms for warning the community (for example, all radio stations) and develop templates for providing information to the media in a real event.	Low	Knowledge, Information, Public and Stakeholder Awareness and Education	Multi-hazard	33
Medium	Regularly test the tsunami warning system by conducting multi-agency exercises (including testing of emergency communication arrangements between key agencies). Complete post exercise lessons learned processes to guide SOP changes and staff training.	Medium	Tsunami Emergency Response (including evacuation)	Tsunami specific	26
Medium	NEMO progresses towards employing a national Public Information Officer to coordinate media liaison and monitoring before, during and after emergency events, lead community awareness programs and transfer information and skills from international and regional partners to benefit DRM in Palau.	Medium	Knowledge, Information, Public and Stakeholder Awareness and Education	Multi-hazard	34

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 5
Medium	Regular communication with near neighbours (for example, the Federated States of Micronesia (FSM), Papua New Guinea (PNG)) both at an operational and planning level will assist all involved to develop capacity to manage and respond to a range of natural hazards. This can be facilitated through involvement in forums such as the Pacific Platform for DRM.	Medium	Regional & International Coordination	Multi-hazard	7
Medium	Participate in the Southwest Pacific Tsunami Working Group of the Intergovernmental Coordination Group Pacific Tsunami Warning and Mitigation System (ICG PTWS) by nominating a representative of Palau to be on this working group. Use this group to learn about regional initiatives and initiatives of other Pacific Island Countries (PICs) with regard to tsunami warning and mitigation systems in small island nations.	Medium	Regional & International Coordination	Tsunami specific	8
Medium	Investigate gaining access to a deep ocean tsunami model scenario database and the ComMIT community model for tsunami inundation (including appropriate training) to enable further determination of more specific threat information for Palau.	High	Research Expertise	Tsunami specific	11
Medium	Develop an information management system (database) to act as a central depository to ensure data available in-country, that may be useful for responding to a disaster, is available for real-time response. This data can also be used for preparedness planning (for example, mapping critical infrastructure).	High	Tsunami Emergency Response (including evacuation)	Multi-hazard	25

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific	Recommendation Number In Table 5
Medium	That Palau (NWS, NEMO with PALARIS and Office for Environmental Response and Coordination (OERC)) with external technical assistance, consider installing a sea level gauge network throughout Palau. This data would provide a better understanding of tsunami and improve reliability of inundation estimations. The data would also have multi-hazard and day to day uses.	Very High	Tsunami Monitoring	Multi-hazard (data can be used for other applications)	13
Medium	Acquire the necessary baseline data for populated areas to fill identified gaps as part of a multi-hazard (storm surge, tsunami, climate change) mapping activity using high resolution data collection methods such as Light Detection and Ranging (LiDAR).	Very High	Tsunami Hazard, Vulnerability, Risk and Mitigation	Multi-hazard	31
Low	Become a member of the Intergovernmental Oceanographic Commission (IOC) to ensure Palau has a voice in determining IOC programmes and activities of benefit nationally as well as benefiting from IOC capacity building in marine science.	Low	Regional & International Coordination	Multi-hazard	9