SOPAC Member Countries National Capacity Assessments:

Tsunami Warning and Mitigation Systems

Papua New Guinea

Papua New Guinea

AUSTRALIA

SOPAC

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Papua New Guinea

Port Moresby,

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Acronyms

ABC	Australian Broadcasting Corporation
ADRC	Asian Disaster Reduction Centre
AFTN	Aeronautical Fixed Telecommunications Network
AGD	Australian Attorney-General's Department
ARM	Atmospheric Radiation Measurement
ATWS	Australian Tsunami Warning System
AusAID	Australian Agency for International Development
Bureau	Bureau of Meteorology
CHARM	Comprehensive Hazard and Risk Management
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
DART	Disaster Assessment and Response
DMPGM	Department of Mineral Policy and Geohazard Management
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EMA	Emergency Management Australia
EMWIN	Emergency Managers Weather Information Network
EOC	Emergency Operations Centre
EU	European Union
GA	Geoscience Australia
GIS	Geographic Information Systems
GTS	Global Telecommunications System
HF	High Frequency
ICG	Intergovernmental Coordination Group
IOC	Intergovernmental Oceanographic Commission
ISCS	International Satellite Communications System
ISDR	International Strategy for Disaster Reduction
ITIC	International Tsunami Information Centre
ITSU	Tsunami Warning System in the Pacific (old title)
JICA	Japan International Cooperation Agency
JMA	Japan Meteorological Agency
LRIT	Long Range Identification and Tracking
MSR	Marine Science Research
Mw	Moment Magnitude
NAP	National Action Plan
NBC	National Broadcasting Corporation
NDC	National Disaster Centre Note in PNG, NDC is also used for the National Disaster Committee; in this report the acronym NDC only refers to the National Disaster Centre.
NEIS	National Earthquake Information Service
NGOs	Non Government Organisations
NWS	National Weather Service
PDC	Provincial Disaster Centre Note in PNG, PDC is also used for the Provincial Disaster Committee; in this report the acronym PDC only refers to the Provincial Disaster Centre.
PGSP	Pacific Governance Support Program
PICs	Pacific Island Countries
PMGO	Port Moresby Geophysical Observatory
PNG	Papua New Guinea
PPRR	Prevention, Preparedness, Response and Recovery

Acronyms (Continued)

PTWC	Pacific Tsunami Warning Centre
PTWS	Pacific Tsunami Warning and Mitigation System
RANET	Radio and Internet for the Communication of Hydro-Meteorological and Climate Related Information
RPNGC	Royal Papua New Guinea Constabulary
RVO	Rabaul Volcano Observatory
Rx	Receive
SOPAC	Pacific Islands Applied Geoscience Commission
SOPs	Standard Operating Procedures
TADEO	Telecommunications and Distance Education Operation
UHF	Ultra High Frequency
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
UPNG	University of PNG
USGS	United States Geological Survey
UTC	Coordinated Universal Time
VCP	Voluntary Co-operation Programme
VHF	Very High Frequency
VSAT	Very Small Aperture Terminal
WMO	World Meteorological Organisation

Section

1

1. Results Outline

1. Results Outline

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 Papua New Guinea (hereafter referred to as "PNG") to receive, communicate and effectively respond to tsunami warnings took place in a workshop held from 21 – 24 October 2008 in Port Moresby, PNG. A return visit in November 2009 further reviewed and cemented the results of the assessment. Since the workshop, some recommendations have progressed. These include review of disaster management legislation and work on tsunami Standard Operating Procedures (SOPs).

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

As well as outlining PNG'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 PNG's tsunami warning and mitigation system.

The vulnerability of PNG's population to tsunami is compounded by the traditional coastal way of life which revolves around living and working by the sea. The size and topography of the country, the limitations of the transport and communications systems and the remoteness of communities makes preparing for, warning for and responding to disasters a challenging task.

In the late 1970s, the late Ian Everingham developed a catalogue of tsunami that had occurred in the then New Guinea and Solomon's region. There have been approximately 50 tsunami in PNG waters in the last hundred years, including moderate events that preceded the eruptions of Rabaul volcano 1937 and 1994 (D1, p. 2). Notable PNG tsunami throughout history include 1855 or 1856 Rai coast tsunami southeast of Madang, 1888 tsunami generated by the collapse of the Ritter Island volcano, 1930 tsunami along the Bogia coast (Madang Province) and in the Ninigo Islands and the devastating Aitape tsunami in 1998 in which more than 2200 people lost their lives (D8). Various studies highlight the main tsunami threat source for PNG as the Solomon's, New Guinea and Mariana trenches. Whilst the majority of tsunami are caused by fault displacements in the sea floor, Papua New Guinea's northern coast is also subject to tsunami which may be caused by submarine volcanic activity, or by the mass wasting of volcanoes.

PNG has also experienced tsunami from distant sources. The 8.4 magnitude 1960 Chile earthquake caused a tsunami arrived in PNG 22 hours later, causing waves of one to two metres in height and some flooding in the New Guinea Islands and at Wewak (Everingham, 1977). The Anchorage, Alaska, earthquake of 1964 generated a tsunami that reached PNG waters 11.5 hours later (D8).

Locally generated events on the northern coast could have very short travel times, such as the 1998 Aitape tsunami which was reported to have arrived 15-20 minutes after the seismic event. Due to the short travel time (10 to 30 minutes) from local sources it is impossible to provide timely warnings. This must be considered in any education planning. Communities must be made aware of the natural warning signs of tsunami (shake, drop, roar, run – Refer to Figure 4).

Disaster Risk Management (DRM) in PNG exists under the framework of the PNG Disaster Management Act (D12). This Act then relies upon the country's National Disaster Management Plan to further establish the framework of responsibility and action for the management of disaster events. The National Disaster Committee exists, as do Provincial Disaster Committees. The National Disaster Centre (NDC - PNG's equivalent of what is referred to as the National Disaster Management Office in Pacific Island Countries (PICs)) and Provincial Disaster Centres exist with varying levels of effectiveness depending on the Province in question.

NDC has ultimate responsibility for issuing warnings for tsunami. Port Moresby Geophysical Observatory (PMGO) receives messages from Pacific Tsunami Warning Center (PTWC) and Japan Meteorological Agency (JMA) via fax and e-mail. PMGO then coordinates with NDC (who receives the same) to issue tsunami warnings (per. comm Lawrence Anton, PMGO, 26 February 2010). Neither the PMGO nor NDC can currently provide the critical 24/7 coverage that is required for a fully effective tsunami warning service. Although plans to rectify this situation are in place, this is currently a significant gap in the country's tsunami warning system. Tsunami warnings are also received by PNG's National Weather Service (NWS), who is 24/7, via Emergency Managers Weather Information Network (EMWIN), Aeronautical Fixed Telecommunications Network (AFTN), Fax and e-mail. The Rabaul Volcano Observatory (RVO) also receives these messages.

Enhancement of the use of current communication systems, as well as implementation of new technologies, could assist to solve the current ineffectiveness of disseminating tsunami and other warnings out of hours. Due to PNG's local tsunami risk, enhanced community awareness and preparedness is vital to ensure communities are prepared for tsunami and act based on warnings received or on natural tsunami warning signs.

Participants in the Tsunami Capacity Assessment workshop stated a number of priority areas for improvement that need to be addressed. Recurring themes included improved coordination, user friendly availability of information and databases, best use of resources, effective protocols for warning dissemination to all stakeholders and more proactive community awareness. The workshop's resulting recommendations reflected these priorities. Very high priority recommendations made include:

- Development of a Tsunami Response Plan that clearly defines the roles, functions, authorities and responsibilities of all organisations and agencies (public and private sector) at the National and Provincial levels.
- Development and documenting of SOPs for all agencies.
- The review of the National Disaster Management Plan to further enhance legislated responsibilities, strengthen the role of the National Disaster Committee and develop strategies to integrate the private sector into the plan.
- Formally review the resource requirements of the NDC and PMGO that would enable them to maintain a 24/7 all-hazard watch and warning service including tsunami (including redundant communications systems).
- Develop a communications plan that includes first alert capability (wake-up call) at remote communities and a strengthened primary tsunami warning communication network.
- Task Provincial Disaster Coordinators to identify and advertise tsunami evacuation routes for the communities in their areas of responsibility.
- Further develop and enhance the current community awareness media campaigns and integrate the disaster awareness initiative, including tsunami, throughout all levels of the education curriculum.

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

Contingent on the availability of human and financial resources, 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.

Figure 1: The Wave. Painting by Lucas Rawah of Aitape (source D10).

1.2. Recommendations (including priority and resource intensity)

Table 2 outlines the priority and resource intensity for recommendations made to improve PNG'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 and with in-country experts during visits to key agencies (including in November 2009). 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 PNG'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 PNG's tsunami warning and mitigation system.

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific benefits	Recommendation Number In Table 4
Very High	Ensure existing communications mechanisms are well used to ensure reliability and save lives by running an education and training program. To be of value in a disaster, all office radios must have the volume up with an operator nearby monitoring. Budget for routine battery replacement and maintenance funds for remote emergency radio stations.	Low	Communications	Multi-hazard	19
Very High	Further develop and enhance the current awareness media campaigns.	Low	Knowledge, Information, Public & Stakeholder Awareness & Education	Multi-hazard	31
Very High	The highest priority is given to the development of a Tsunami Response Plan that clearly defines the roles, functions, authorities and responsibilities of all organisations and agencies (public and private sector) at the National and Provincial levels.	Medium	Governance & Coordination	Tsunami Specific	1
Very High	Development and documenting of SOPs for all agencies, these documents need to be coordinated between agencies.	Medium	Governance & Coordination	Tsunami Specific	2
Very High	Formally review the resource requirements of the NDC and PMGO that would enable them to maintain a 24/7 all-hazard watch and warning service, including tsunami. This must include formal review of communications system requirements, training and maintenance.	Medium	Tsunami Warnings	Multi-hazard	12

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific benefits	Recommendation Number In Table 4
Very High	Develop a consolidated communications plan: The plan could include: **a.** More VSAT (Very Small Aperture Terminal) stations with connections to HF and cellular networks; **b.** The purchase and installation of secure ground station equipment; **c.** Develop a funding plan to cover reoccurring satellite costs, maintenance and training for sustainability; **d.** Install a VHF (Very High Frequency) base at the NWS, since it is the only 24/7 office that is equipped with HF (High Frequency), fax and data links; **e.** Data exchange traffic handled by the Port Moresby NWS staff from remote VSATs; **f.** Educate all health, religious and government HF/VHF capable networks to the fact that the NWS is monitoring a HF/VHF channel; and, **g.** Strengthening of communication systems at PMGO and NDC.	Medium	Communications	Multi-hazard	20
Very High	Strengthen the primary tsunami warning communication network to ensure that tsunami information is received and actioned in a timely manner regardless of the hour. Design and develop a back-up network.	Medium to High (depending on action taken)	Communications	Multi-hazard	18

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific benefits	Recommendation Number In Table 4
Very High	Review the National Disaster Management Plan, including: **a.** Ensure sound legislation exists for DRM responsibilities and warnings at a national and Provincial level; **b.** Further strengthen the role and authority of the National Disaster Committee and associated subcommittees, integrating tsunami consideration into these committees in an all hazard approach; and **c.** The development of strategies to integrate the private sector into the plan.	High	Governance & Coordination	Multi-hazard	4
Very High	Investigate a communication system that provides a first alert capability (wake-up call) at remote communities (such as the RANET (Radio and Internet for the Communication of Hydro-Meteorological and Climate Related Information) Chatty Beetle that can be triggered by the responsible warning agency to wake up village leaders).	High	Communications	Multi-hazard	17
Very High	Task Provincial Disaster Coordinators to identify and advertise tsunami evacuation routes for the communities in their areas of responsibility.	High	Tsunami Emergency Response (including evacuation)	Tsunami Specific	22
Very High	Integrate the disaster awareness initiative, including tsunami, throughout all levels of the education curriculum. Ensure this includes natural warning signs for tsunami and action that should be taken by communities in response to these signs or receiving a warning from authorities.	Low	Knowledge, Information, Public & Stakeholder Awareness & Education	Multi-hazard	33

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific benefits	Recommendation Number In Table 4
High	Ensure that project agreements with international donors for upgrade of equipment includes sharing of data internationally in real time and suitable data formats to facilitate improvements of accuracy of messages from international tsunami warning providers.	Low	Tsunami Monitoring Infrastructure	Tsunami Specific	11
High	Re-establish the National Disaster Committee Communications Working Group to coordinate multi-agency communication systems.	Low	Communications	Multi-hazard	16
High	Test, evaluate and validate the viability of existing and newly developed SOPs via a practical exercise prior to their operational adoption and then on a regular basis.	Low	Tsunami Emergency Response (including evacuation)	Tsunami Specific	21
High	Appoint a “public information officer” with responsibility to develop and enhance a multi-hazard awareness campaign at the community level.	Low	Knowledge, Information, Public & Stakeholder Awareness & Education	Multi-hazard	32
High	Review the current process for the receipt of tsunami warnings to improve the timeliness of dissemination and redundancy in the receipt and dissemination system.	Medium	Tsunami Warnings	Tsunami Specific	13
High	A position of Emergency Co-ordinator for recovery be established at NDC.	Medium	Tsunami Emergency Response (including evacuation)	Multi-hazard	23

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific benefits	Recommendation Number In Table 4
High	Complete comprehensive tsunami hazard analysis and mapping to enhance the warning system and identify vulnerable areas based on the tsunami catalogue, past areas of inundation, Geographic Information Systems (GIS) data and deep ocean models to identify low-lying communities which may be prone to tsunami impacts from all likely sources. Make the information readily accessible in a user-friendly format.	Medium	Tsunami Hazard, Vulnerability, Risk & Mitigation	Tsunami Specific	24
High	Identify training needs by completion of a training needs analysis and development of a national training strategy for DRM in PNG (including a database to track progress).	Medium	Knowledge, Information, Public & Stakeholder Awareness & Education	Multi-hazard	34
High	Continue work towards completion of a PNG DRM National Action Plan (NAP) to allow for a nationally coordinated and strategic approach to DRM in PNG.	High	Governance & Coordination	Multi-hazard	5
High	Strengthen the capacity of PMGO to fully utilise, maintain and sustain the new seismic network, including developing a maintenance program funded by the PNG Government.	High	Tsunami Monitoring Infrastructure	Multi-hazard	9
High	On completion of natural hazards (including tsunami inundation) modelling, revise the building code, at least for critical infrastructure.	High	Tsunami Hazard, Vulnerability, Risk & Mitigation	Multi-hazard	30
High	Introduce a competency-based training approach to the development of skills and knowledge in the field of DRM across key government agencies. This should include development of a tsunami competency-based training program for the operational staff of key agencies to reflect tsunami operational practices as outlined in developed SOPs.	High	Knowledge, Information, Public & Stakeholder Awareness & Education	Multi-hazard	35

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific benefits	Recommendation Number In Table 4
Medium	The contact list recorded from this workshop is expanded to provide an all-hazards contact list as a reference group for liaison and further development to effectively meet the tsunami threat.	Low	Governance & Coordination	Multi-hazard	3
Medium	Consideration is given to a "twinning" arrangement with an international agency that has operational tsunami warning responsibility	Low	Governance & Coordination	Multi-hazard	6
Medium	Develop the protocols for the reception of international technical experts for impact assessments post tsunami and other disasters.	Low	Research Expertise	Multi-hazard	7
Medium	Log all warning messages received and transmitted by the responsible warning agency and key recipients.	Low	Tsunami Warnings	Multi-hazard	14
Medium	Establish a national scientific body/committee to co-ordinate, prioritise and facilitate the exchange of existing tsunami research.	Medium	Research Expertise	Tsunami-specific	8
Medium	Develop a media program to raise awareness of the importance and need for the respect of early warning equipment and prevent vandalism.	Medium	Tsunami Monitoring Infrastructure	Multi-hazard	10
Medium	Continue integrated all-hazard Community-Based DRM programs for at risk communities.	Medium	Tsunami Hazard, Vulnerability, Risk & Mitigation	Multi-hazard	25
Medium	Establish a database of traditional knowledge on early warning signs and coping mechanisms, including recovery. The study should include capturing disaster stories.	Medium	Tsunami Hazard, Vulnerability, Risk & Mitigation	Multi-hazard	26
Medium	Identify potential losses due to tsunami impacts as an advocacy and planning tool to encourage investment in tsunami risk reduction.	Medium	Tsunami Hazard, Vulnerability, Risk & Mitigation	Tsunami Specific	27

Priority	Recommendation	Resource Intensity	Topic	Multi-hazard or tsunami specific benefits	Recommendation Number In Table 4
Medium	Investigate how the use of available scientific information (deep ocean tsunami models, coastal and deep ocean sea level data, travel time software, and eventually seismic data) can be used by the scientific and warning agencies to localise the tsunami threat to PNG.	High	Tsunami Warnings	Tsunami Specific	15
Medium	Acquire high resolution near-shore bathymetry and topography data to enable tsunami inundation modelling of major urban centres at risk as part of a multi-hazard mapping activity.	Very High	Tsunami Hazard, Vulnerability, Risk & Mitigation	Multi-hazard	28
Medium	Investigate options for completing tsunami inundation modelling, particularly for population and infrastructure centres that are identified as being vulnerable to tsunami.	Very High	Tsunami Hazard, Vulnerability, Risk & Mitigation	Tsunami Specific	29

Section

2

2. Project Background

2. Project Background

2.1. About the Project

The National Capacity Assessment of 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 Australian Bureau of Meteorology (the Bureau) is the lead implementing agency, in partnership with the Australian Attorney-General's Department (AGD), (formerly Emergency Management Australia (EMA)), SOPAC, and with the assistance of the Intergovernmental Oceanographic Commission (IOC) a division of the United Nations Educational, Scientific and Cultural Organization (UNESCO). The project is funded by the Australian Agency for International Development (AusAID) under the Pacific Governance Support Program (PGSP). It is implemented under an agreement (Schedule 5 to the Record of Understanding 14304, June 2006) between AusAID and the Bureau). The fourteen SOPAC member countries participating in the project are the Cook Islands, the Federated States of Micronesia, Fiji, Kiribati, the Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, the Solomon Islands, Tonga, Tuvalu and Vanuatu.

2.2. Broad Project Aim

By undertaking an assessment of the capacity of individual nations to manage tsunami events, the project aims to better guide donor funding towards achieving targeted improvements in the tsunami warning and mitigation systems in the respective countries.

2.3. Key Project Output

The key deliverable of the project is a comprehensive set of reports, including one national report specific to each country, detailing the strengths and opportunities for improvement of the country with regard to tsunami warning and mitigation. The national report for each country also includes recommendations to address priority issues. These reports will then feed into a consolidated Regional report that will aim to identify common issues across the Region with regard to tsunami warnings and mitigation.

2.4. Project Methodology

National assessments in each SOPAC member country are conducted by visiting teams including experts in the fields of tsunami warnings, emergency management, disaster risk reduction and data and warning communications. The visiting team meets with in-country experts during four-day workshop involving government agencies, the private sector, NGOs and regional and international organisations involved in tsunami and natural disaster management.

The workshop aims to complete a questionnaire covering all aspects of tsunami warning and mitigation and gather information to support questionnaire responses. This information then feeds

into the national report. Consultation with individual countries before completion of the report is an integral part of the report writing process.

The questionnaire for the PICs is a modified version of that used for the Indian Ocean equivalent project. The Indian Ocean questionnaire was jointly developed by UNESCO/IOC, SOPAC, the World Meteorological Organisation (WMO) and the International Strategy for Disaster Reduction (ISDR). Details of the Indian Ocean equivalent project can be found at http://ioc3.unesco.org/indotsunami/nationalassessments.htm

2.5. Underlying Policy Objectives of the Australian Tsunami Warning System Project

The Bureau in partnership with Geoscience Australia (GA) and AGD, has recently completed a four-year project to establish the Australian Tsunami Warning System (ATWS). One of the three policy objectives of the ATWS project was "To contribute to the facilitation of tsunami warnings for the South West Pacific" (DFAT, 2006). The Tsunami Capacity Assessment project and this report, contributes to the achievement of this policy objective. Also, as part of the implementation of the ATWS, Australia has and will continue to contribute to the facilitation of more effective tsunami advisory bulletins to Pacific Island nations through the provision of seismic and sea level observations to the PTWC in Hawaii.

2.6. Tsunami warnings in the Pacific

Tsunami messages for the Pacific Ocean are issued by the PTWC in Hawaii as the United States of America contribution to the PTWS. Individual countries are then responsible for using this advice to distribute national tsunami warnings to their communities. PTWC messages can be Tsunami Warnings, Tsunami Watches, Tsunami Advisories and Tsunami Information Bulletin/Statement. For the purpose of this report, products from the PTWC will be referred to generically as 'tsunami messages'. A full definition of each PTWC products can be found at http://www.prh.noaa.gov/ptwc/about_messages.php

2.7. International Tsunami Forums

Under the auspices of the IOC, the Intergovernmental Coordination Group (ICG) for the Pacific Tsunami Warning and Mitigation System (PTWS) (formerly known as ICG for the Tsunami Warning System in the Pacific (ITSU)) was first convened in 1968 (IOC, 2009). This is an international cooperative effort involving many IOC Member States of the Pacific Region. The ICG/PTWS meets regularly to review progress and coordinate activities resulting in improvements of the service (IOC, 2009).

The Working Group on Tsunami Warning and Mitigation in the Southwest Pacific Ocean was formed at the ICG/PTWS-XXI meeting in Melbourne in early May 2006 with the aim of enhancing tsunami warning and mitigation in the Southwest Pacific Ocean. The membership of the working group is composed of representatives from IOC Member States and other countries in the region (as members and observers). SOPAC provides secretariat support. The Working Group is currently chaired by a representative of New Zealand, with vice-chairs from Fiji and Samoa.

The Working Group has a number of Terms of Reference and this project is directly relevant to the following Terms of Reference:

- To evaluate capabilities of countries in the Southwest Pacific Region for providing end-to-end tsunami warning and mitigation services;
- To ascertain requirements from countries in the Southwest Pacific Region for the tsunami warning and mitigation services;
- To facilitate capacity building and the sharing of tsunami information in the region;
- To support the further development of the virtual centre of expertise in a multi-hazards context within SOPAC in line with the Regional Early Warning Strategy; and
- To facilitate the inclusion of tsunami hazard and response information into curricula, and development and dissemination of education materials.

3. Country Background and the Tsunami Threat

3. Country Background and the Tsunami Threat

3.1. About Papua New Guinea

The mainland of PNG, together with its six hundred other islands (463,000 square kilometres), has a population of approximately 6.1 million people. Most of the people are Melanesian, but some are Micronesian or Polynesian. There are over seven hundred language groups, reflecting the diverse origins of the people. English, Tok Pisin (Pidgin), and Motu (the lingua franca of the Papuan region) are the official languages (DFAT, 2009). PNG independence from Australia was proclaimed in 1975.

The spectrum of PNG society now ranges from traditional village-based life, dependent on subsistence and small cash-crop agriculture, to modern urban life in the main cities of Port Moresby (capital), Lae, Madang, Wewak, Goroka, Mt Hagen, and Rabaul. Some 85 per cent of the population directly derive their livelihood from farming, and 15 per cent of the population live in urban areas. It is estimated that the population is growing at a rate of approximately 2.7 per cent per year (DFAT, 2009).

PNG is a constitutional monarchy. The Head of State is HM Queen Elizabeth II, represented in PNG by a Governor-General. PNG has three levels of government - national, provincial and local. The National Parliament is a 109-member unicameral legislature elected for five year terms by universal suffrage. The Prime Minister is appointed and dismissed by the Governor-General on the proposal of Parliament. The Cabinet – or National Executive Council – is appointed by the Governor-General on the recommendation of the Prime Minister (DFAT, 2009).

Members of Parliament are elected from 19 provinces and the national capital district of Port Moresby. Parliament is made up of 89 single-member electorates and 20 regional electorates. The regional electorates coincide with PNG's provinces and the National Capital District – members from these electorates also serve as the provincial Governors. Each province is responsible for its own provincial assembly and administration (DFAT, 2009).

PNG has a dual economy comprising a formal, corporate-based sector (with a heavy reliance on mineral extraction) and a large informal sector where subsistence farming accounts for the bulk of economic activity. In comparison to other PICs, PNG is in a reasonably strong economic position, with the savings it accrued during the commodity boom now acting as a fiscal buffer against the global credit crunch (DFAT, 2009).

PNG is susceptible to a number of natural hazards that can result in emergency or disaster situations for the country. These include volcanic hazards, earthquakes (with the danger posed primarily from resulting landslides or tsunami), landslides caused by uplift and erosion, climate change and El Nino, tropical cyclones, floods, frost, fire and public health concerns such as HIV/AIDS or the cholera outbreak in August 2009 etc.

Figure 2: Papua New Guinea

3.2. Tsunami Threat Sources and Tsunami History in Papua New Guinea

Much of the information contained within this section was taken from material written by Hugh Davies (UPNG).

An overview of potential tsunami threat sources and tsunami history in PNG is outlined below. This information should be treated as general background only and does not attempt to complete a comprehensive picture of tsunami hazard and vulnerability for PNG. Such a study is outside the scope of this project.

Earthquake activity in PNG occurs along each of the plate boundaries where the Pacific Plate slides under the Australian Plate and in the fold belt of the Papuan Basin (D8). In PNG the greatest release of earthquake energy is on the Momase coast and hinterland and in New Britain, southern New Ireland and Bougainville (D8). Despite the high seismicity of the New Guinea and Solomon Islands region, there is relatively little loss of life due to the physical damage of earthquakes alone. The greatest threat earthquakes cause to life in PNG is from landslides triggered by the earthquake, such as happened in the Finisterre Range in 1993 and 2000 (D8) as well as tsunami.

> *"We rely to some extent on the written record about which parts of our coastline have been affected [by tsunami] in the past, as one means of predicting what may happen in the future". (D1, p. 18)*

In the late 1970s, the late Ian Everingham developed a catalogue of tsunami that had occurred in the then New Guinea and Solomons region. There have been 50 tsunami in PNG waters in the last hundred years, including moderate events that preceded the eruptions of Rabaul volcano 1937 and 1994 (D1, p. 2). Notable PNG tsunami throughout history are outlined below.

- 1855 or 1856 – A tsunami destroyed a village on the Rai coast southeast of Madang, with loss of most lives (D8, p. 59).
- 1888 - One of the most severe tsunami in PNG history was caused by the collapse of one flank of the Ritter Island Volcano. This generated a wave up to 12 metres high that caused great devastation and loss of life along the New Britain coast and the Siassi Islands and also affected Huon Peninsula and Rai coast (D1, p. 2).
- 1895 – A tsunami caused deaths along the Oro coast, from Buna to Cape Nelson, and in the Amphlett Islands (D8, p. 59).
- 1930 – A seven metre high tsunami caused some deaths along the Bogia coast (Madang Province) and in the Ninigo Islands (D8, p. 59).
- 1998 – The tsunami that hit the coast of west Aitape on the evening of 17 July 1998 was the first damaging tsunami for 68 years in PNG (since the 1930 tsunami which impacted upon Madang Province). The tsunami energy was focused on a 14km stretch of coastline west of Aitape. In this area two large villages were completely destroyed, two others were extensively damaged, and more than 2200 people lost their lives. Further to the east and west the damage was less severe (D8, p. 60). The tsunami was caused by a massive submarine landslide that occurred 13 minutes after the earthquake at 7.02pm local time. The landslide occurred approximately 30km offshore from Arop and Warapu, where the sea is 1.5km deep. The tsunami wave travelled towards the shore and became focused towards Arop and Warapu by moving more rapidly in the deep water of a submarine canyon and more slowly across the broad shallow shelf that extends offshore from Arop and Warapu (D8, p. 64). The PMGO recorded two strong quakes that Friday evening, one at 6.49pm and the other at 7.09pm. Both were recorded to be of 7.0 magnitude with the

second one being slightly stronger (D1, p. 2). The earthquakes were strongly felt and continued for several minutes. The tsunami arrived 15 to 20 minutes after the first earthquake and was preceded by a fall in sea level, a feature of all previous PNG tsunami (D1, p. 2). The tsunami consisted of a series of three waves. Post event education after the 1998 Aitape tsunami was completed by the University of PNG (UPNG) with information put together at the university and some educational material provided by International Tsunami Information Centre (ITIC).

PNG has also experienced tsunami from distant sources. The 8.4 magnitude 1960 Chile earthquake caused a tsunami which arrived in PNG 22 hours later, causing waves of one to two metres in height and some flooding in the New Guinea Islands and at Wewak (Everingham, 1977). The Anchorage, Alaska, earthquake of 1964 generated a tsunami that reached PNG waters 11.5 hours later (D8).

> *"Recollections of the last major tsunami pass from living memory before the next occurs." (D1, p. 2)*

The vulnerability of PNG's population to tsunami is compounded by the traditional coastal way of life lived by many communities which revolves around living and working by the sea. The size and topography of the country, the limitations of the transport and communications systems and the remoteness of communities makes preparing for, warning for and responding to disasters a challenging task.

> *"The Sisters at Malol tried desperately to let the outside would know of the tragedy [the Aitape tsunami] on the evening of Friday 17 July but were unable to make any contact until the scheduled Mission Radio the next morning". (D1, p. 28)*

Thomas, Burbidge and Cummins (2007) completed *A Preliminary Study into the Tsunami Hazard faced by Southwest Pacific Nations*. Scenarios for an 8.5 Moment Magnitude (Mw) and 9.0 Mw earthquakes were used to investigate normalised offshore (to a notional depth of 50 metres) wave amplitudes for tsunami caused by earthquakes along subduction zones (Refer Figure 2). In this study, PNG's maximum amplitude for all Mw 8.5 tsunami would be 310cm with the most significant source region being the South Solomons, New Guinea and Mariana trenches. For a Mw 9.0 tsunami the maximum amplitude increased to 340cm, maintaining the significant sources listed above but adding Nankai, Ryukyu, Aleutians, Kuril, new Hebrides and Philippines (the study doesn't take into account whether these trenches can support a Mw 9.0 earthquake).

A further study completed by Thomas and Burbidge (2009) attempts to answer the question "which Pacific nations might experience offshore amplitudes large enough to potential result in hazardous inundation, what are the probabilities of experiencing these amplitudes and from which subduction zones might these tsunami originate". The report breaks PNG down into two sub-groups (1) New Britain, New Ireland and Bougainville and (2) South and West. The following are extracts from this report.

(1) New Britain, New Ireland and Bougainville (Thomas and Burbidge 2009, p. 37)

The report states that the hazard from this region comes predominantly from the Solomons trench which lies close to the south of Bougainville and New Britain. This is reflected in the amplitudes at a 2000 year return period, with values up to 3.6 and 3.0 metres on the southern coasts of New Britain and Bougainville respectively. There are also significant contributions from the Mariana and Philippines trenches, with lesser contributions from the New Guinea and Kuril trenches. The amplitudes (2000 year return period) on the northern coastlines of these islands are somewhat lower, though still reaching 2.4 metres on New Britain, and 2.0 metres on Lantangai and Bougainville. At a 100 year return period amplitudes vary from 0.2 to 0.5 metres throughout the region.

(2) South and West PNG (Thomas and Burbidge 2009, p. 38)

The largest maximum amplitudes for a 2000 year return period were computed at model output points near Kiriwina and Woodlark (up to 3.9 metres), the northern coast of Louisiade Archipelago (up to 3.1 metres) , and the western part of the northern coastland of the mainland (up to 3.3 metres). The source of the hazard for the region is dominated by the Solomons trench (which affects the areas south of latitude 6°S, and the New Guinea trench, which affects areas further west and north. The hazard along the southern coasts of the mainland and the Louisiade Archipelago is lower. At a return period of 100 years, maximum amplitudes of 0.4 to 0.5 metres are expected along the northern coasts of the mainland and the Louisiade Archipelago, and near Kiriwina and Woodlark.

Travel times for tsunami from these sources outlined above vary because of the distributed nature of the islands and the complexity of the sea-bed within the archipelagos but are typically between less than one to three hours from the Solomons trench and less than an hour from the New Guinea trench. For distant sources, the travel time is considerably longer (for example, Alaskan source 11 hours, Chilean, 21-22 hours).

In PNG there are 14 active and 22 dormant volcanoes that pose a threat to around 240,000 people (D8). Volcanic activity is associated with the New Britain Trench, the Makira Trench and the Trobriand Trough. No volcanic activity occurs close to the New Guinea Trench (D8). Whilst the majority of tsunami are caused by fault displacements in the sea floor, PNG's northern coast is also subject to tsunami which may be caused by submarine volcanic activity, or by the mass wasting of volcanoes. An example is the Ritter Island tsunami of 1888 (D8). This risk was recently outlined in research completed by UPNG which indicates that the volcanic islands in the Bismarck Sea are subject to periodic slope collapses that generate destructive tsunami (D47).

Locally generated events on the northern coast could have very short travel times, such as the 1998 Aitape tsunami which was reported to have arrived within 15-20 minutes after the seismic event. Due to the short travel time (10 to 30 minutes) from local sources it is near impossible to provide timely warnings. This must be considered in any education planning. Communities must be made aware of the natural warning signs of tsunami (shake, drop, roar, run – Refer to Figure 4).

> *"It has been the common experience in PNG in the past, though not always true, that the negative or low part of the wave arrives before the positive or high part" (D8) causing the sea to recede before the tsunami arrives.*

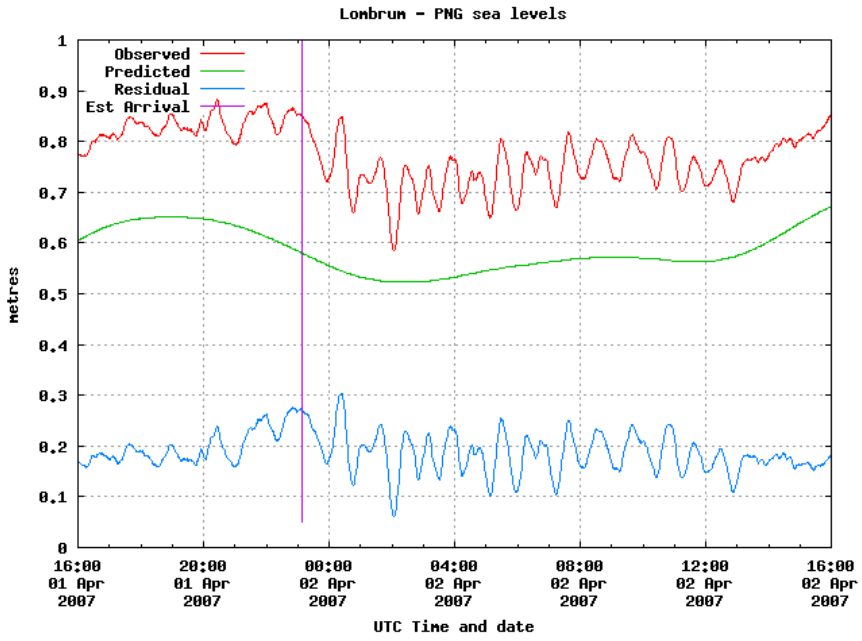

Figure 3: The 1 April 2007 Solomon Islands Tsunami as detected at Lombrum, PNG. The residual curve shown in blue indicates the initial wave arrived as a reduction in wave height at approximately 00UTC on 2 Apr. A series of waves were recorded for the next 12 hours, with the maximum positive wave heights estimated to be between 10-20cm (source: Bureau of Meteorology National Tidal Centre)

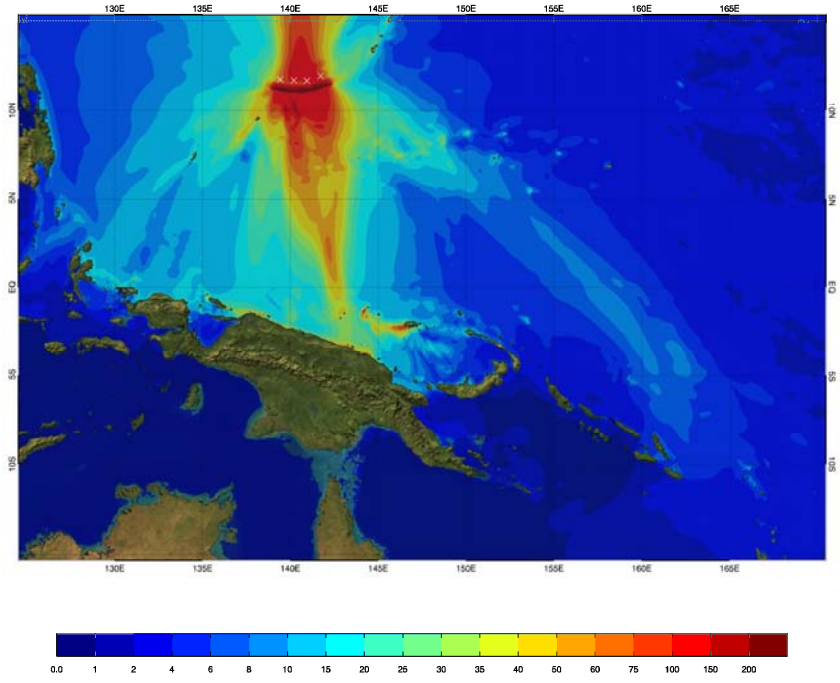

Figure 4a: Maximum amplitude tsunami from magnitude 8.5 Mw earthquake scenario on the Mariana Trench showing tsunami energy beamed towards PNG (Source: Scenario 273c of MOST model from T2 database, Greenslade, Simanjuntak and Allen, 2009).

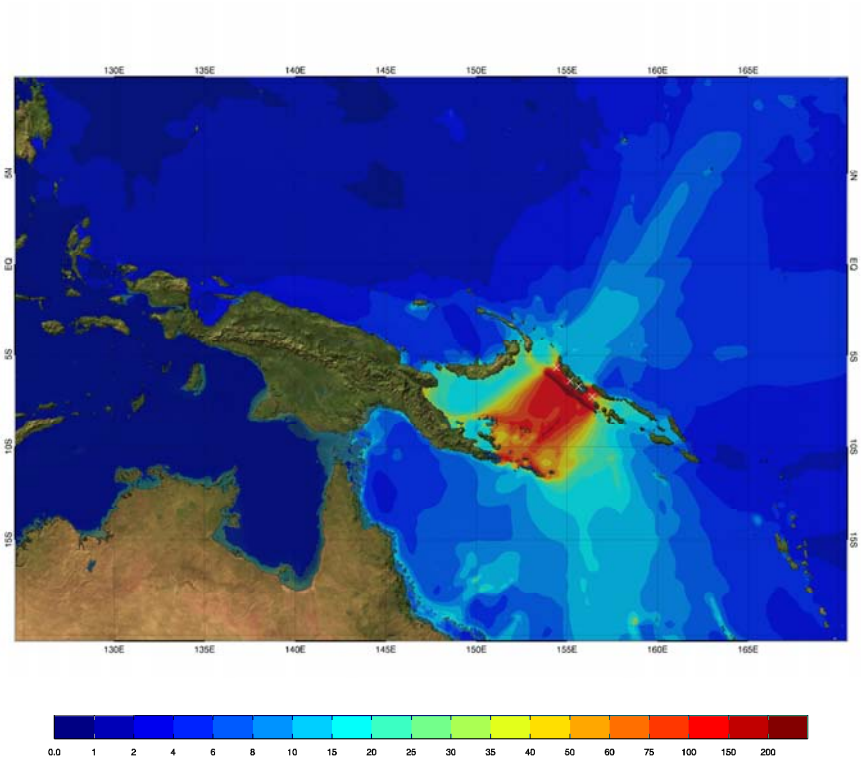

Figure 4b: Maximum amplitude tsunami from magnitude 8.5 Mw earthquake scenario on the San Cristobal Trench showing tsunami energy beamed towards PNG (Source: Scenario 170c of MOST model from T2 database, Greenslade, Simanjuntak and Allen, 2009).

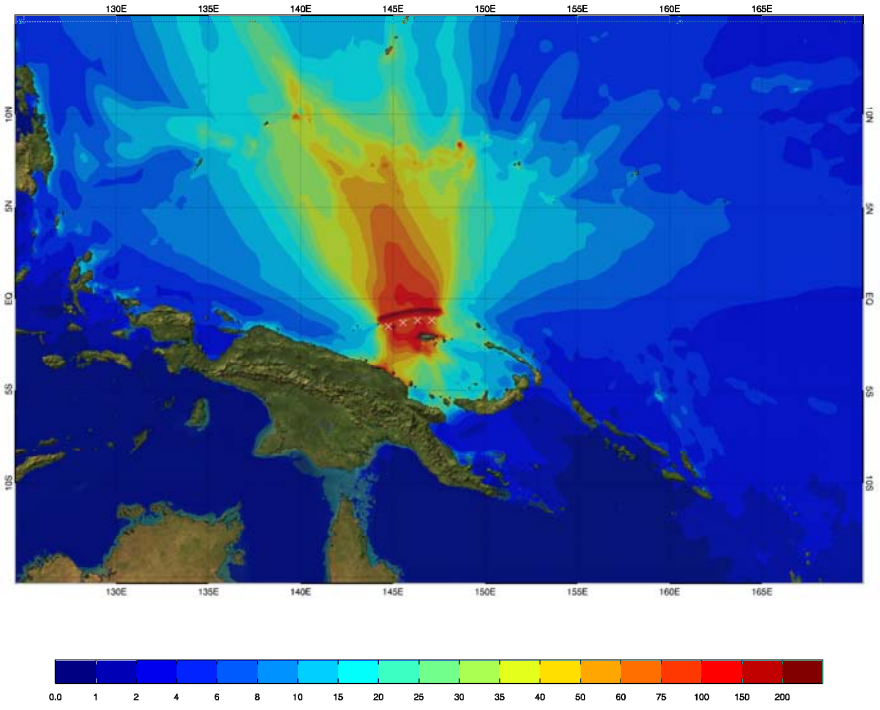

Figure 4c: Maximum amplitude tsunami from magnitude 8.5 Mw earthquake scenario on the New Guinea Trench. Although most energy propagates northward, significant tsunami energy is beamed southward towards PNG (Source: Scenario 147c of MOST model from T2 database, Greenslade, Simanjuntak and Allen, 2009).

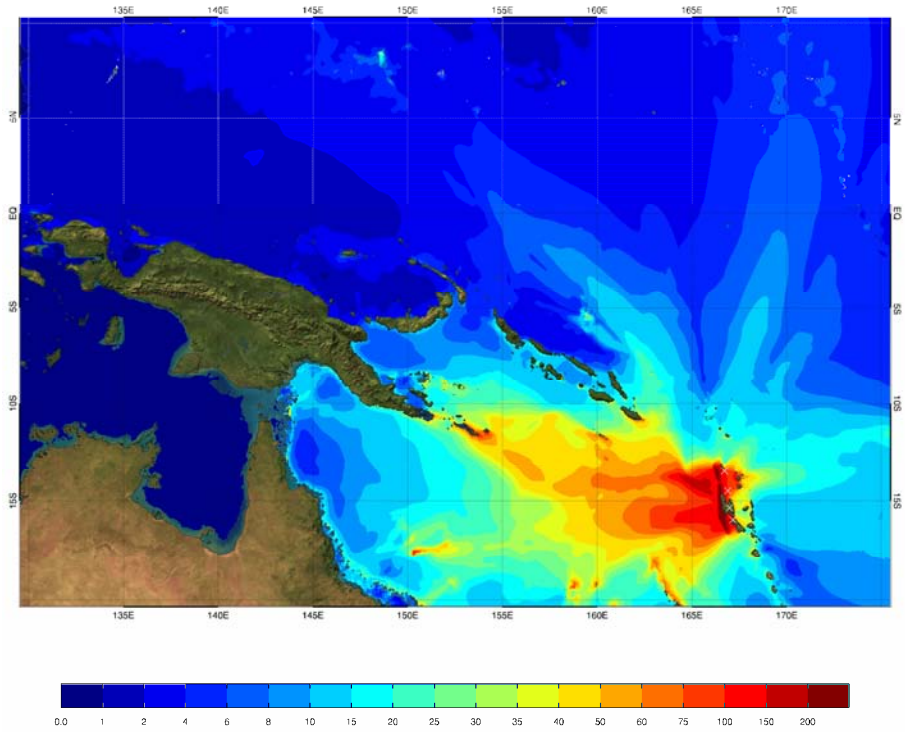

Figure 4d: Maximum amplitude tsunami from magnitude 8.5 Mw earthquake scenario near Vanuatu showing tsunami energy beamed towards PNG (Source: Scenario 187c of MOST model from T2 database, Greenslade, Simanjuntak and Allen, 2009).

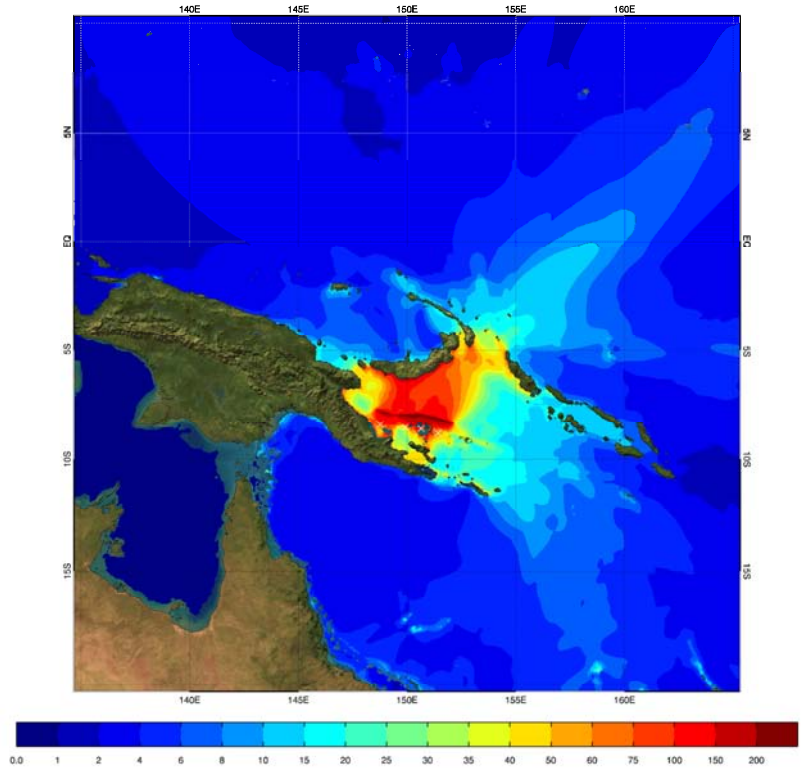

Figure 4e: Maximum amplitude tsunami from magnitude 8.5 Mw earthquake scenario north of the Kiriwina Islands showing tsunami energy beamed towards PNG (Source: Scenario 161c of MOST model from T2 database, Greenslade, Simanjuntak and Allen, 2009).

Figure 5a: The subduction zones (in orange) of the Pacific Ocean

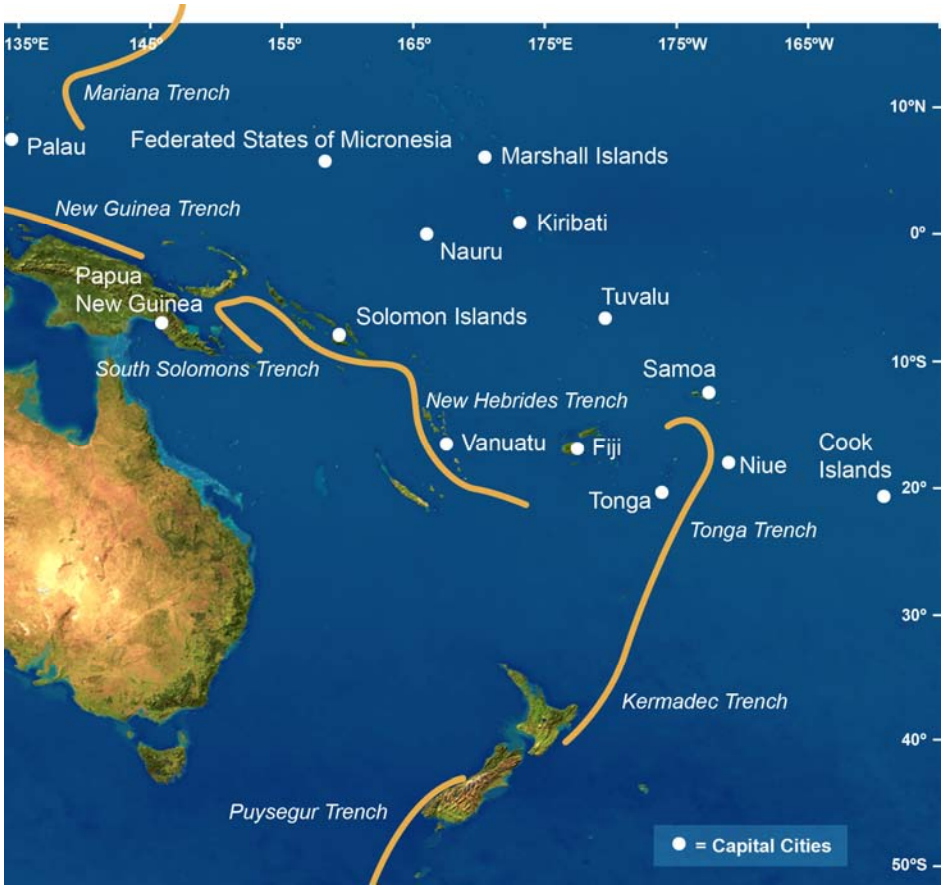

Figure 5b: The location of PNG (as denoted by its capital Port Moresby) and other PICs in relation to regional and local subduction zones (in orange)

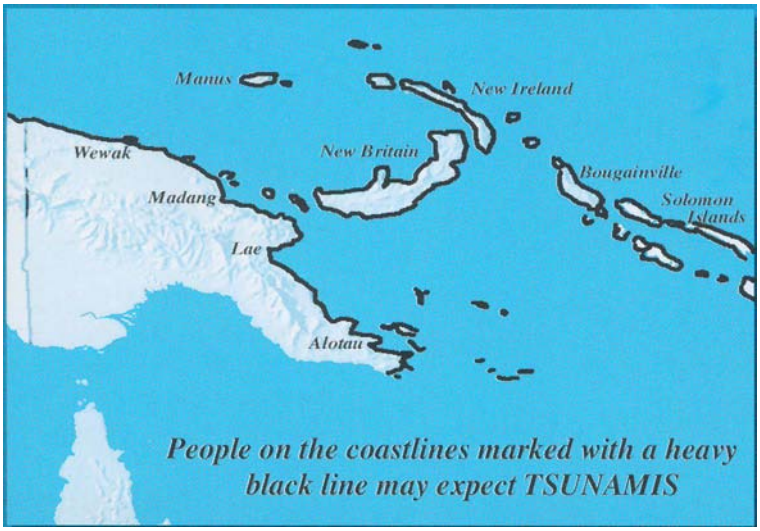

Figure 6: Heavy line marks coastline at risk from tsunami (source: D10, Map by rtapng and UPNG).

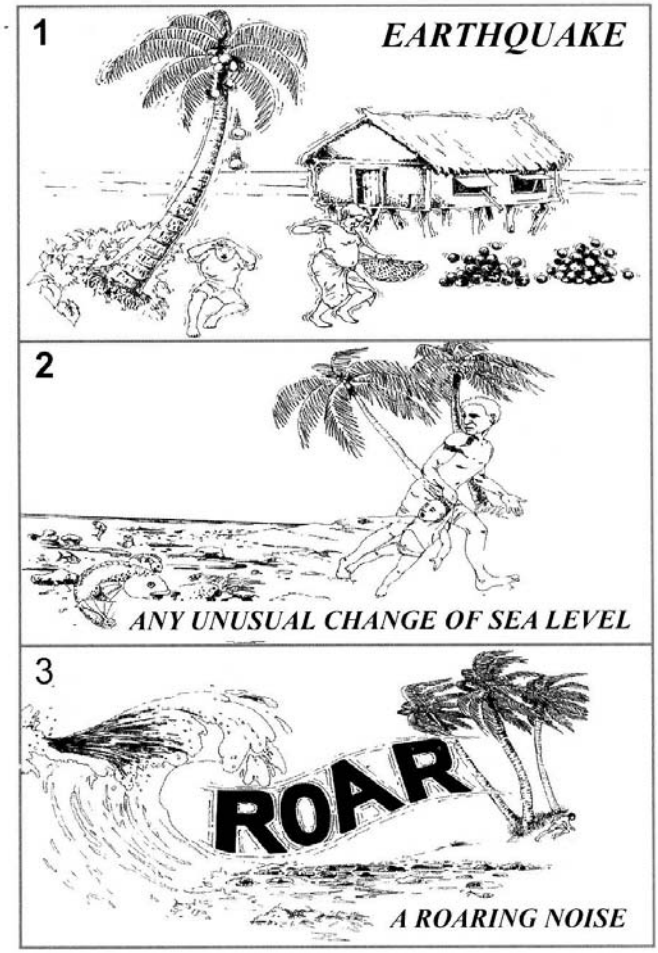

Figure 7: Tsunami drawings by Michael John (source: D10).

4. The PNG Tsunami Capacity Assessment

4. The Papua New Guinea Tsunami Capacity Assessment

4.1. Date and Location

The tsunami capacity assessment of the ability of PNG to receive, communicate and effectively respond to tsunami warnings took place from 21 to 24 October 2008, at the Hideaway Hotel, Port Moresby, PNG.

4.2. Visiting Assessment Team and Participants

The Visiting Assessment Team was made up of those outlined in Annexure 2. The focal point in PNG for the organisation of the workshop was Mr Jimmy Gomoga, Assistant Director of Operations at the Papua New Guinea NWS. A full list of workshop participants can be found in Annexure 1.

4.3. Workshop Summary

For a copy of the full agenda for the workshop see Annexure 3.

4.3.1. Day 1 (Tuesday 21 October 2008)

The meeting was opened in prayer by Pastor Chessley, followed by opening addresses from Mr Tau Vali, Deputy Secretary of the Department of Provincial and Local Government Affairs (representing the Department Secretary, Mr Zurenuoc). The Visiting Assessment Team Leader, Mr Gordon Jackson, then responded on the team's behalf. All participants at the workshop were then invited to introduce themselves and their role in the PNG tsunami mitigation and warning system.

Presentations were given by Visiting Assessment Team members and local experts to introduce the participants to the workshop aims, tsunami characteristics, regional impacts and an overview of tsunami monitoring and warning.

After lunch the participants were divided into four focus groups to discuss PNG's priorities for the enhancement of their tsunami warning and mitigation system. Focus groups included the following topics:

- Risk Reduction;
- Monitoring, Warning and Dissemination;
- Response and Recovery; and
- Community Awareness.

The meeting then went on, with workshop participants discussing and recording answers to the Tsunami Capacity Assessment Questionnaire (refer to Attachment 1a).

4.3.2. Day 2 (Wednesday 22 October 2008)

Opening presentations by Gordon Jackson and Bruce Best introduced participants to tsunami warning and communication systems. Following this, the workshop continued with the Tsunami Capacity Assessment Questionnaire.

After lunch the Visiting Assessment Team members all visited the NDC and toured their facilities. Gordon Jackson and Bruce Best then visited the PNG NWS where detailed discussions were held with Jimmy Gomoga (Assistant Director Operations) and Tau Gabu (Acting Director) on NWS communications systems and warning receipt, preparation and dissemination. Michael Bonte-Grapentin visited the PMGO to hold detailed discussions with Chris McKee and Mathew Moihoi on the tsunami hazard, post-event assessments and the role of PMGO. Steve Banks remained at the NDC for further discussions and to complete relevant questions with Martin Mose and Andrew Oaego.

The workshop appeared on National Broadcasting Corporation's (NBC's) national TV news coverage on the second day.

4.3.3. Day 3 (Thursday 23 October 2008)

Steve Banks opened the day with a presentation on Emergency Coordination and Planning and Community Awareness. The group then moved on to completing sections of the Tsunami Capacity Assessment Questionnaire. This was simplified by questions being completed at the NDC and PMGO on the previous afternoon.

After lunch the group was divided into three to discuss and report on the PNG's tsunami warning system's strengths, weaknesses, opportunities and threats. The session finished with general discussion.

4.3.4. Day 4 (Friday 24 October 2008)

The final day was chaired by Jimmy Gomoga and commenced with a presentation from Gordon Jackson on the preliminary findings and recommendations from the assessment team for the PNG Tsunami Warning and Mitigation System. Unfortunately, due to an earthquake in the Admiralty Islands that morning, many of the key people were late in attending. Closing remarks and addresses were given by Kaigabu Kamninga (NDC) and Eric Ani (NGO, ex-NDC). Further discussions were held during the final morning tea.

After the workshop Jacqueline Smart of the Australian High Commission in Port Moresby arranged several media opportunities to increase awareness of the workshop including:

- Australian Broadcasting Corporation (ABC) TV interviews with Gordon Jackson, Jimmy Gomoga and Eric Ani;
- Photographs taken by the Post Courier; and
- An NBC radio interview with Gordon Jackson and Jimmy Gomoga.

At least one other radio station used the disseminated media release to run a story on the workshop.

Team leader, Gordon Jackson, visited Mark Wedd from AusAID at the Australian High Commission in Port Moresby to discuss the results of the assessment on the Friday afternoon.

4.4. Workshop Photos (Port Moresby October 2008)

PNG Tsunami Capacity Assessment Workshop participants

Workshop participants discuss PNG's tsunami system priorities in Focus Groups

The PNG National Weather Service visit

Martin Mose, Andrew Oaego, Jimmy Gomoga and Steve Banks in discussion at the National Disaster Centre

Tsunami Assessment Workshop Participants convene at the Hideaway Hotel in Port Moresby

5. Assessment Results

5. Assessment Results

5.1. Status of Key System Components

The Tsunami Capacity Assessment Workshop results are summarised below in Table 3 in which the status of key components of the PNG tsunami warning and mitigation system are outlined (as at the date the Tsunami Capacity Assessment Workshop was held in October 2008, and updates completed during the November 2009 review).

Table 3: Summary of current status of key components of PNG's tsunami warning and mitigation system as at October 2008 and review November 2009.

Rating

Yes – fully realised
Partially realised
No – not realised

Key Component	Rating	Comment
Authority, Coordination and NGO Role		
Legislation in place for tsunami warnings and response	**No**	PNG does have a Disaster Management Act (D12). However, this does not outline responsibilities for DRM, including tsunami warnings. The National Disaster Management Plan is relied upon to establish this framework. However, the Disaster Management Plan requires review (D13, current version 1987) to sufficiently outline responsibilities at the National and Provincial level.
Tsunami coordination committee or effort at a National and local level	**No**	There is no specific Tsunami Coordination Committee. The National Disaster Committee or Provincial Disaster Committees can be convened. However, further enhancement of these forums is required.
Agency responsibilities clearly defined	**No**	Agencies know their responsibilities but this is not documented. The Disaster Management Plan requires review (D13, current version 1987) to sufficiently outline responsibilities at the National and Provincial level.
NGOs and Red Cross Society have a defined role in tsunami warning dissemination, preparedness and awareness and emergency response	**Partially**	NGOs undertake primarily emergency response and awareness activities. Further integration of these capabilities in national DRM planning could significantly enhance national preparedness and response capacity. The PNG Red Cross Society Disaster Preparedness and Response Plan (D5) is detailed and contains some extremely useful information.

Key Component	Rating	Comment
International and Regional Cooperation		
Country represented at an international and regional level to aid cooperation in tsunami warning and mitigation efforts	**Yes**	Provides some data into tsunami system and involved in some bilateral engagement and international tsunami and DRM forums.
Priorities		
Priorities established for implementation of tsunami warning and mitigation system at a National level	**Partially**	Priorities for PNG's tsunami warning and mitigation system were discussed and recorded in the Tsunami Capacity Assessment Workshop (Refer to Annexure 8). These could be further formalised in DRM and tsunami plans.
Multi-hazard Approach		
Tsunami warning capabilities are being established within a multi-hazard framework	**Yes**	Through the Disaster Management Act (D12) and the National Disaster Management Plan (D13) a multi-hazard framework is undertaken.
Research Expertise		
Active research is being undertaken within the country for seismology and tsunami to strengthen the tsunami warning and mitigation system	**Partially**	Doing baseline research survey work primarily through PMGO and UPNG as well as international partnerships.
Tsunami monitoring infrastructure		
Existence of seismograph stations and integration of real time data from these stations into the tsunami warning process	**No**	Currently only one Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) station at Gerehu and one station at PMGO operational. PMGO link to CTBTO seismic stations in the Region via Telikom VSAT to receive earthquake information on request. Funding secured through the European Union (EU) B-envelope to re-establish the seismic network (**Update March 2010** – Currently progressing through a tender process). New system with ten stations and telemetry (satellite and telephone) planned for 2009/11.
Existence of sea level stations and integration of real time data from these stations into the tsunami warning process	**Yes**	There is one Seaframe sea level station at Lombrum, Manus and three stations at Rabaul. All stations are telemetered to RVO. The Lobrum station reports to the Global Telecommunications System (GTS) and is available to PTWC. The Rubaul stations are currently not available to PTWC.
Sharing of seismic and sea level data internationally to facilitate improvement of PTWC tsunami messages for the region	**Partially**	CTBTO seismic station is, as is the Lombrum sea-level station.

Key Component	Rating	Comment
Warnings/Communications		
Nation receives PTWC messages	**Yes**	PMGO receives messages from PTWC and JMA via fax and e-mail. NWS, who are 24/7, also receive PTWC and JMA tsunami messages via EMWIN, AFTN, Fax and e-mail. There is a in-office system that is alarmed. NDC and RVO also receive these messages.
24/7 operational staff at warning receipt and dissemination location	**Yes**	PMGO and NDC is not reliably 24/7. NWS is 24/7.
Disseminate national tsunami warnings as guided by a Standard Operating Procedure	**No**	SOPs have been developed for earthquakes and tsunamis to assist PMGO during events, with the assistance of PTWC and ITIC. They are being used (per. comm. Lawrence Anton, PMGO, 26 February 2010). SOPs in draft form or non existent for wider agencies involved in tsunami warning and response. (**Update March 2010** – PMGO and NDC are currently progressing enhancement of SOPs (per. comm. AusAID Port Moresby, 19 March 2010)).
System redundancies in place for receipt of PTWC messages and dissemination of National warnings	**No**	Messages received at multiple offices (PMGO, NWS, NDC and RVO) but some of these agencies are not staffed 24/7..
Redundant 24/7 methods available for dissemination of warnings to community (e.g. public radio, sirens etc.)	**No**	Yes 8am to 5pm Monday to Friday but not after hours or on weekends. Systems are often not located in 24/7 staffed offices, systems are turned off or volume is down. Only the FM and AM National Broadcast Stations are on 24/7. Other (mostly church related or sponsored) broadcast media is off air before midnight. Many remote communities are not covered by any free to air broadcast systems without elaborate antennas. EU funding for upgrade to 24/7 communication for NDC received.
Effective warning dissemination to remote communities	**No**	Not reliable unless warnings coincide with the HF schedule of a health or church radio network.
Communications coverage of whole country that is effectively utilised for the dissemination of tsunami warning messages	**Partially**	No sirens, no country wide warning system. Less than 60 percent cell coverage. Communications systems (primarily radio) is not coordinated to consider 24/7 warning capability.

Key Component	Rating	Comment
Warnings/Communications (Continued…)		
Issue of marine tsunami warnings and guidance for vessels, harbours and ports	**Partially**	The Port Moresby radio station (HF) broadcasts weather every two hours 8am to 6pm Monday to Friday only.
Emergency Response and Evacuation		
Disaster preparedness and emergency response system has been reviewed and opportunities for improvement and training identified	**Partially**	Only implemented for Manus
Tsunami emergency response, evacuation and recovery plan exists	**No**	Emergency response, evacuation and recovery plans do not currently exist for tsunami.
The designated agency for evacuation is identified and have authority by law	**No**	Legislation surrounding public evacuations is lacking. Most evacuations are voluntary.
Plans have been made for safe evacuation of population centres including aspects such as maps, routes and signage	**Partially**	Plans are limited to only two Provinces at this time.
Procedures are tested and exercised to improve the response through better planning and preparedness	**Partially**	At limited Provincial level only.
Land use policies and building codes are in place to mitigate against the tsunami hazard	**No**	Building codes and enforcement need review/revision.

Key Component	Rating	Comment
Tsunami hazard, vulnerability and risk		
Completion of studies to assess the tsunami hazard in the country or Region	**Partially**	This is based primarily on a good historical database of events. Baseline information is available.
Local risk assessments have been completed for at risk communities	**Partially**	Tsunami risk studies along the north coast and the risk of tsunami generated by volcanic cone collapse have been investigated by UPNG and RVO respectively, sometimes with assistance from international partners such as Hokkaido University. Some vulnerability and local risk assessments have been completed in PNG (Refer to Attachment 1a, Question 77 and 78).
Adequate data exists and local inundation modelling has been completed for population centres	**No**	Some numerical modelling studies have been completed to calculate inundation from tsunami in PNG (primarily modelling of past events).
Public and Stakeholder Awareness, Education and Training		
Measures have been taken to ensure the public understand and take action in the event of a tsunami warning being issued	**Yes**	Ongoing awareness programs and activities, including media campaigns, are conducted by a number of agencies, with a number of donor funds and some agency budget funds.
Community level education and preparedness programs exist for tsunami	**Partially**	All hazards training. The UPNG takes a key role in community education and disaster management training in PNG. Their Geology and Disaster Reduction course includes tsunami (see D28 for the course outline).
Training programs for the National media exist for natural hazard and tsunami	**Partially**	No formal training programs, but a number of meetings have been held to clarify roles and awareness talk has been made for future translation and dissemination.
Training programs exist for officials involved in tsunami warning and response	**No**	Training specific to tsunami is lacking for key warning and response agencies. Tsunami competency-based training program for the operational staff of key agencies are required to reflect tsunami operational practices as outlined in developed SOPs.

5.2. Case Study – Tsunami System Operation in PNG for the April 2007 Solomon Islands Tsunami Event

Throughout the Tsunami Capacity Assessment process completed in PNG, the country's response to the Solomon Islands event of April 2007 was reviewed. The aim of this review was to gain an understanding of the operation of the system in a real time event.

Event Details: Solomon Islands – Magnitude 8.1, 45km south-southeast of Gizo (Solomon Islands), 20:39:56 Coordinated Universal Time (UTC), Sunday 1 April 2007 (2 April, 6:39am Port Moresby local time). PNG were placed under a tsunami warning in the first PTWC bulletin issued at 20:55 UTC, Sunday 1 April 2007 (2 April, 6:55am Port Moresby local time).

The seismic event was detected at the PMGO office at 6:30am, but no one was in the office until about 8:00am. No support staff existed to attend to analysis and an overwhelming number of phone calls were received. RVO detected the seismic event also but no analysis was undertaken.

The event was recorded by RVO at the Rabaul sea level gauges. These gauges detected a wave of approximately 0.8 metres. Previous information had been obtained by observers in Bougainville of a wave of approximately two metres. The Lombrum sea level gauge also detected the event. NWS Misima Weather office confirmed that an abnormal sea level rise occurred over the wharf area only.

International tsunami advisory messages for this event were received from PTWC (refer to D3). The PMGO, NWS, NDC and RVO received these messages. Of these, only the NWS is currently staffed 24/7. NDC issued a warning to media via radio to Milne Bay Province within 20 minutes. Word of mouth proved somewhat effective however the warning was not received by all potential impact areas. PMGO was not staffed at time of initial warning. In addition to the information disseminated by NDC, the NWS issued warning to standard address list (issued by the Assistant Director of Operations through the Director) stating that "a small tsunami was generated and some coastal areas may have seen some sort of effect but the effect was not significant for any drastic result". The warning said that "between 7.24am and 9.50am this morning the generated Tsunami wave should have reached PNG coastal areas. This has not eventuated, indicating the Tsunami threat has elapsed".

The public responded with confusion and overreaction in some areas (Madang and Wewak). Some thought it was an April fool's joke and constantly rang to confirm legitimacy. However, people in many coastal areas had been aware of the warning and were expecting impact of tsunami.

PNG did not have a national tsunami response plan in place at the time of this event.

5.3. Strengths, Opportunities for Improvement and Recommendations to Progress the Tsunami Agenda in Papua New Guinea

Based on the discussions during the workshop with in-country participants and the supporting documentation collected during the visit, the visiting team, in consultation with Tsunami Capacity Assessment Workshop participants formulated the following strengths, opportunities for improvement and recommendations under key topics which they believe will progress the tsunami agenda in PNG. These are outlined in Table 4.

Table 4 –Strengths, opportunities for improvement and recommendations under key topics

5.3.1. Governance and Coordination

Strengths:	Opportunities for Improvement:
• National Disaster Management Plan (D13, 1987) exists and National Disaster Mitigation Policy (2003, D37) exists and is earmarked for review. • Development of DRM NAP planned. • SOPs have been developed for earthquakes and tsunami to assist PMGO during events, with the assistance of PTWC and ITIC. They are being used (per. comm. Lawrence Anton, PMGO, 26 February 2010). • The Disaster Management Act (Chapter 403) (2004, D12) "makes provision with respect to emergencies arising out of epidemics, earthquakes, volcanic eruptions and other disasters". The Act establishes: o The National Disaster Committee for National policy coordination. No tsunami working group exists. o A Provincial Disaster Committee in each province chaired by the Provincial Administrator. Provincial Disaster Centres (PDC) also exist. No tsunami specific structures at the Provincial level. o The NDC that coordinates all disaster situations. o Outlines National / Provincial arrangements for the funding of disaster relief costs. • National Disaster Management Plan (January 1987, D13) aims to encourage local self reliant effort, allocates responsibilities to agencies and departments and puts in place procedures for international assistance for emergency situations.	• SOPs in draft form or non existent for wider agencies involved in tsunami warning and response. **Update March 2010** – PMGO and NDC are currently progressing enhancement of SOPs (per comm. AusAID Port Moresby, 19 March 2010). • The National Disaster Management Plan (D13, 1987) requires review including thorough review of lead agencies and agency roles and responsibilities. • Limited, inconsistent funding. • Limited staff with the appropriate skills and training. • Lack of coordinated multi-agency approach to DRM. • Improvements in the effectiveness of the National Disaster Committee could be achieved. • Guidelines for Provincial contingency plans are included in the National Disaster Management Plan (D13, 7-2). However, preparedness planning in some Provinces requires enhancement. • Subcommittees exist, but need re-invigoration and co-ordination.

Governance and Coordination (Continued)	
Strengths:	**Opportunities for Improvement:**
• In general, PNG's disaster risk management policies include an all-hazards approach. • National Disaster Awareness and Preparedness Sub-Committee (technical agencies (NWS, PMGO, RVO, etc.), universities), National Disaster Committee (Finance, Defence, Provincial Affairs, NGOs, Red Cross). There is also a United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA) sponsored standing committee on disaster management. • NGOs have a role to play in all areas of disaster risk management, depending on the NGO in question. Active NGOs in PNG include Red Cross, World Vision, Oxfam, Caritas, Salvation Army, Adventist Development and Relief Agency and Care Australia. In some instances they are the first responders to disasters. Many are involved in community awareness programs.	• (Refer above)

Recommendations:

1. The highest priority is given to the development of a Tsunami Response Plan that clearly defines the roles, functions, authorities and responsibilities of all organisations and agencies (public and private sector) at the National and Provincial levels.
2. Development and documenting of SOPs for all agencies, these documents need to be coordinated between agencies.
3. The contact list recorded from this workshop is expanded to provide an all-hazards contact list as a reference group for liaison and further development to effectively meet the tsunami threat.
4. Review the National Disaster Management Plan, including:
   a. Ensure sound legislation exists for DRM responsibilities and warnings at a national and Provincial level;
   b. Further strengthen the role and authority of the National Disaster Committee and associated subcommittees, integrating tsunami consideration into these committees in an all hazard approach; and
   c. The development of strategies to integrate the private sector into the plan.
5. Continue work towards completion of a PNG DRM NAP to allow for a nationally coordinated and strategic approach to DRM in PNG.

5.3.2. Regional and International Coordination

Strengths:	Opportunities for Improvement:

• PNG is involved in the international tsunami network for advisory and technical expertise, issue of early warnings and international coordination.
• PNG became a member of IOC in 2006.
• PNG Department of Planning Coordinate international missions (with four weeks notice required).
• Entry of foreign experts and press into the country is covered under the National Disaster Management Plan (January 1987, D13).
• Attend international workshops on all hazards including tsunami.
• A number of international partnerships exist including:
  ○ Twinning programme between RVO and GA (public awareness, improve understanding of volcanic hazards (including tsunami)).
  ○ GA support to UPNG Disaster Risk Reduction centre (for tsunami inundation modelling as part of a multi-hazard project.
  ○ Japan International Cooperation Agency (JICA) proposal to establish disaster course at UniTec, Lae.
  ○ AusAID support of NDC and support of community awareness.
  ○ EU/SOPAC 1 Million EURO to PMGO to re-establish and upgrade the seismic network.
  ○ RVO arrangement with Hokkaido University in Japan for tsunami modelling.
  ○ University California Santa Barbara working on Geohazard Management including tsunami work.
  ○ Earthquake and tsunami PNG coordinates with National Earthquake Information Service (NEIS) of the United States Geological Survey (USGS), GA, the Harvard University Seismology Centre, the Comprehensive Nuclear Test-Ban Treaty Organisation (CTBTO) and the PTWC.
	• Scope for an existing operational warning centre to assist in operational, procedural and technical aspects of tsunami warning provision and delivery.

Regional and International Coordination (Continued)
Recommendations:
6. Consideration is given to "twinning" arrangement with an international agency that has operational tsunami warning responsibility.

5.3.3. Research Expertise

Strengths:	**Opportunities for Improvement:**
• Technical expertise exist in-country. Important organisations include: ○ PMGO (Department of Mineral Policy and Geohazard Management (DMPGM)) for survey work, seismic network, event analysis and reports, maintaining tsunami and earthquake catalogues. ○ UPNG (Centre for DRR established 2003) for tertiary education (disaster risk management course), tsunami awareness (post Aitape tsunami), tsunami inundation modelling, paleo-tsunami studies (Solomon Islands, NW-coast PNG). ○ PNG University of Technology, Lae – JICA proposal to establish disaster course. ○ RVO – Monitor volcanic activity and research in PNG. ○ NWS – Monitor weather and climate and issue warnings for related hazards. ○ MSR – Marine Science Research, collection of seismic and bathymetric data • International technical partnerships exist.	• Improved prioritisation of scientific research that will assist DRM, through enhancement of DRM strategy. • Improved co-ordination of existing research.

Recommendations:

7. Develop the protocols for the reception of international technical experts for impact assessments post tsunami and other disasters.

8. Establish a national scientific body/committee to co-ordinate, prioritises and facilitate the exchange of existing tsunami research.

5.3.4. Tsunami Monitoring Infrastructure

Strengths:	Opportunities for Improvement:
• Some capacity with information receiving and detection systems (EMWIN, seismographs, sea level gauges). • PMGO was established 1957 and operated a national seismic network starting in the 1960s, with major upgrade in 1980s with up to 16 stations countrywide, operational until about 1998. Currently only one CTBTO station at Gerehu and one station at PMGO operational. PMGO link to CTBTO seismic stations in the Region via Telikom VSAT to receive earthquake information on request. • RVO has seismic stations for volcano monitoring at 12 sites in Rabaul, three in West New Britain (Pago, Ulawun, Garbuna), one in Manam, one in Karkar and one in Mount Lamington. Linked via HF telemetry to RVO with data probably in real time. • There is one Seaframe sea level station at Lombrum, Manus and three stations at Rabaul. All stations are telemetered to RVO. The Lobrum station reports to Melbourne via GTS and is available to PTWC. The Rabaul stations are currently not available to PTWC.	• Funding secured through the EU B-envelope to re-establish the seismic network (**Update March 2010** – Currently progressing through a tender process). New system with ten stations and telemetry (satellite and telephone) planned for 2009/11. • Seismic data is currently shared in a limited way with the international community. However, there are opportunities for expansion in the future. • Some sea-level data is not currently shared with the international community (the Rabaul Stations).

Recommendations:

9. Strengthen the capacity of PMGO to fully utilise, maintain and sustain the new seismic network, including developing a maintenance program funded by the PNG Government.

10. Develop a media program to raise awareness of the importance and need for the respect of early warning equipment and prevent vandalism.

11. Ensure that project agreements with international donors for upgrade of equipment includes sharing of data internationally in real time and suitable data formats to facilitate improvements of accuracy of messages from international tsunami warning providers.

5.3.5. Tsunami Warnings

Strengths:	Opportunities for Improvement:
• NDC (who usually have someone on 24/7) are an all hazards warning and response centre that have the ultimate responsibility for issuing warnings for tsunami. • PMGO receives messages from PTWC and JMA via fax and e-mail (with an after hours phone switched to residences). NWS, who are 24/7, also receive PTWC and JMA tsunami messages via EMWIN, AFTN, Fax and e-mail. There in office system is alarmed. NDC (via fax and e-mail) and RVO (via e-mail) also receive these messages. • PMGO then coordinates with NDC to issue tsunami warnings (per comm. Lawrence Anton, PMGO, 26 February 2010). • SOPs have been developed for earthquakes and tsunami to assist PMGO during events, with the assistance of PTWC and ITIC. They are being used (per comm. Lawrence Anton, PMGO, 26 February 2010). • The received international warnings go out over police VHF and Ultra High Frequency (UHF) radios and over church, maritime, Red Cross, and health HF radio networks. NDC has a HF system and can communicate to remote HF radio networks. • NWS has in the past rephrased international messages for local use and fax to the national media (FM/AM radio, TV stations) and 100 other recipients (organisations, provincial officers, NDC, ports, church groups etc.) in populated areas that are serviced by Telikom using a tsunami warning address list (D4). They have also issued cancellations. • PMGO issues a bulletin for major earthquakes greater than Mw6.5 and informs the media. This is a set procedure and is not outlined in SOPs. • Local church and ward groups disseminate warnings through formal or informal community methods (conch shell, school/church bells) after experiencing an earthquake or noticing a sudden sea level drop or after receiving a warning through the health radio network. • Warning cancellations are issued based on expected travel times for the entire PNG coastline.	• Neither PMGO nor NDC are reliably 24/7 at present. NWS are 24/7. • SOPs in draft form or non existent for wider agencies involved in tsunami warning and response. (**Update March 2010** – PMGO and NDC are currently progressing enhancement of SOPs (per comm. AusAID Port Moresby, 19 March 2010)). • Lack of data on tsunami, especially the inability to quickly distinguish tsunami potential earthquake. • No legislation is established for tsunami warnings (refer to Governance and Coordination). • Marine weather forecasts and warnings are issued to major ports and Port Moresby marine radio station via fax and e-mail. Port Moresby marine radio then warns vessels over Channel 16 Marine (VHF 156.8 MHz) and over 4125.0 and 6510.0 KHz HF channels. • EU Funding has been received for upgrading to 24/7 communication system in NDC.

Tsunami Warnings (Continued)

Recommendations:

12. Formally review the resource requirements of the NDC and PMGO that would enable them to maintain a 24/7 all-hazard watch and warning service, including tsunami. This must include formal review of communications system requirements, training and maintenance).

13. Review the current process for the receipt of tsunami warnings to improve the timeliness of dissemination and redundancy in the receipt and dissemination system.

14. Log all warning messages received and transmitted by the responsible warning agency and key recipients.

15. Investigate how the use of available scientific information (deep ocean tsunami models, coastal and deep ocean sea level data, travel time software, and eventually seismic data) can be used by the scientific and warning agencies to localise the tsunami threat to PNG.

5.3.6. Communications (for further details refer to Annexure 7)

Strengths:	Opportunities for Improvement:

• Basic communication network exists primarily underpinned by HF radios, telephones (including two mobile networks), fax and e-mail. In general, radio systems are not capable of sending and receiving digital data.
• NWS has EMWIN (x3) at their main office in Port Moresby (which provides back-up to fax notification) and at the Misima office. The NWS are capable in data interpretation.
• Nineteen VSAT Telikom systems across PNG. The VSAT in Manus is used for the Atmospheric Radiation Measurement (ARM) project and in Kavieng for CTBTO. There is an Internet Protocol VSAT at UPNG.
• Red Cross with 6 Iridium handhelds (voice and data) on standby.
• NWS has AFTN connected to all major PNG airports.
• NWS: upgrade of satellite receiving system through WMO/Voluntary Cooperation Project (VCP) with UK funding.
• Satellite phones exist. The Red Cross has six Iridium phones with data capability (two in Port Moresby and four in provinces). RVO has an Iridium voice only satellite phone.
• Mobile coverage of 60% of the country with an aim to cover 90% in the next three years. System is text message capable.
• Telikom and private cellular carriers are exploring broadcast systems (for example, SMS) for warning with NDC and toll free calling for public during emergencies number 113, countrywide.
	• Need for improved communications system coordination. A consolidated communications plan, including an end to end approach, is required for the country. PMGO and NDC communications systems require review to run a robust 24/7 operation.
	• Lack of funds, difficult logistics (many vulnerable remote populations) and lack of security for remote equipment such as solar powered earth station facilities.
	• Satellite phone database is not kept.
	• No mobile coverage of 40% of the country.
	• Improve emergency communications to remote areas is required.
	• National Disaster Committee Communications Working Group used to exist. Reviving this group could be beneficial.
	• Long Range Identification and Tracking (LRIT), International Satellite Communications System (ISCS), GTS, RANET and EMWIN at Alotau not working. NWS and NDC would like to rectify this. Expertise is needed to bring these and the VSAT/Rx systems online.
	• NWS communications systems down include:
	  ○ Port Moresby Airport has RANET system that is not commissioned.
	  ○ There is an ISCS earth station at the NWS but does not work (never properly installed).
	  ○ NWS GTS was down at the time of the visit (since 2006).
	  ○ Alotau EMWIN is not working (needs software upgrade, no longer supported).
	• Systems are often not located in 24/7 staffed office, systems are turned off or volume is down. Aitape operators called over HF channels for hours with no response in the 1998 tsunami.
	• Out of hour/weekend warnings are not reliably received in the remote areas of PNG (including marine warnings).
	• Only the FM and AM National Broadcast Stations are on 24/7. Other (mostly church related or sponsored) broadcast media is off air before midnight. Many remote communities are not covered by any free to air broadcast systems without elaborate antennas.

Communications (Continued)

Recommendations:

16. Re-establish the National Disaster Committee Communications Working Group to coordinate multi-agency communication systems.

17. Investigate a communication system that provides a first alert capability (wake-up call) at remote communities (such as the RANET Chatty Beetle that can be triggered by the responsible warning agency to wake up village leaders).

18. Strengthen the primary tsunami warning communication network to ensure that tsunami information is received and actioned in a timely manner regardless of the hour. Design and develop a back-up network.

19. Ensure existing communications mechanisms are well used to ensure reliability and save lives by running an education and training program. To be of value in a disaster, all office radios must have the volume up with an operator nearby monitoring. Budget for routine battery replacement and maintenance funds for remote emergency radio stations.

20. Develop a consolidated communications plan: The plan could include:

- **a.** More VSAT stations with connections to HF and cellular networks;
- **b.** The purchase and installation of secure ground station equipment;
- **c.** Develop a funding plan to cover reoccurring satellite costs, maintenance and training for sustainability;
- **d.** Install a VHF base at the NWS, since it is the only 24/7 office that is equipped with HF, fax and data links;
- **e.** Data exchange traffic handled by the Port Moresby NWS staff from remote VSATs;
- **f.** Educate all health, religious and government HF/VHF capable networks to the fact that the NWS is monitoring a HF/VHF channel; and,
- **g.** Strengthening of communication systems at PMGO and NDC.

5.3.7. Tsunami Emergency Response (including evacuation)

Strengths:	Opportunities for Improvement:
• The PNG Red Cross Society Disaster Preparedness and Response Plan (D5) outlines the society's roles and responsibilities in Prevention, Preparedness, Response and Recovery (PPRR) for disaster management. The plan also outlines operational procedures for disaster preparedness and response including a Disaster Assessment and Response (DART) team. Tsunami are included in the plan along with other useful information such as national arrangements, contacts, and the location of Disaster Preparedness stores. • Manus Province Disaster Plan has been developed and adopted. • General information for low-lying areas to move to higher ground, guides public awareness material, no specific criteria determined for evacuation, dealt on a case-by-case basis. • Signage has been used in West New Britain (Kimbe Bay and Lae City) for volcano/tsunami; Evacuation routes and evacuation centres have been identified. Consideration has been given to incorporating this into Community-Based Disaster Risk Management training activities. • PNG participated in Pacific Wave 2006 and 2008 at the agency level (not down to the community level). • NDC have participated in national and international exercises. Some provincial exercises are conducted. • Some capacity assessments of existing disaster management systems have been completed (for example, United Nations Development Programme (UNDP) undertaking capacity assessment in Oro Province).	• Legislation surrounding public evacuations is lacking. Most evacuations are voluntary. • No national tsunami preparedness and response plan exists. • No evacuation drills are completed in communities and no evacuation plans or assessment of lead times to evacuate communities has been completed. This may not be relevant for local events, where community awareness is most vital. • Although the GIS Map Server of DMPGM offers some GIS capability to NDC with some baseline layers available, at the time of the workshop it was not functioning. E-mail, internet and the NDC website are the existing information/decision making assistance tools available for emergency response. Data bases have not been produced. • Consideration of planning for critical infrastructure and lifeline support facilities in the case of a tsunami or other natural disaster has not been completed. • Draft National adaptation of regional Framework DRM Framework – Provinces (2005), has not been formally endorsed by PNG Government. However the principles are already being practically applied. • Formalisation of procedures for designation of agency for evacuation and declaration of state of emergency. Currently NDC asks police for evacuation. For declaration of State Of Emergency, Chairman NDC requests head of Police/Defence.

Recommendations:

21. Test, evaluate and validate the viability of existing and newly developed SOPs via a practical exercise prior to their operational adoption and then on a regular basis.

22. Task Provincial Disaster Coordinators to identify and advertise tsunami evacuation routes for the communities in their areas of responsibility.

23. A position of Emergency Co-ordinator for recovery be established at NDC

5.3.8. Tsunami Hazard, Vulnerability, Risk and Mitigation

Strengths:	Opportunities for Improvement:
• Extensive database of historical tsunami and earthquake events (1768 – 2008). PMGO, plans to update catalogue and compile event reports. • The PNG Red Cross Disaster Preparedness and Response Plan (D5) ranks tsunami as a high risk hazard for PNG and outlines an estimated tsunami vulnerability by province. The plan also Ranks PNG's capacity to manage the tsunami hazard as moderate to poor. • Some mangrove planting and sea walls have been completed. • PMGO is responsible for identifying tsunami hazard and risk in PNG. • PMGO performs post disaster assessments of major earthquakes and tsunami. RVO sometimes performs similar independent surveys, particular, if tsunami are triggered by volcanic activity. UPNG was heavily involved in the post Aitape assessments. Larger tsunami have also had external scientific involvement (like Aitape 1998 and Wewak 2002). For a list of extensive post tsunami surveys completed for the Aitape 1998 tsunami refer to Appendix 1, a, Question 73. • Tsunami risk studies along the north coast and the risk of tsunami generated by volcanic cone collapse have been investigated by UPNG and RVO respectively, sometimes with assistance from international partners such as Hokkaido University. • Some vulnerability assessments have been completed in PNG (Refer to Attachment 1, a, Question 77). • Some local risk assessments of at risk communities have been carried out in PNG (Refer to Attachment 1, a, Question 78). • Some numerical modelling studies have been completed to calculate inundation from tsunami in PNG (primarily modelling of past events) (Refer to Attachment 1, a, Question 79). PMGO staff attended an IOC modelling course in 2006 and two UPNG students attended training by GA. • There is some inclusion of communities in deciding risk avoidance and mitigation activities (for example, the Community-Based Disaster Risk Management projects). • Comprehensive Hazard and Risk Management (CHARM) program has been developed and adopted. • GA tsunami hazard studies have been completed.	• Hazard information is not utilised to enhance tsunami warning or mitigation activities • No non-structural mitigation measures, such as land-use policies regarding the location and building of structures and public utilities, have been implemented in PNG on a broad scale. Some land use restrictions may apply for Sissano Lagoon. • Post tsunami assessment reporting, data submission and involvement of PNG agencies has not been always to the full satisfaction of PNG stakeholders; external (international) agencies undertaking surveys and not sharing with PNG agencies. • PMGO would like to work further on tsunami inundation modelling in the future, pending availability of resources and capacity. • Patchy, detailed near-shore bathymetry is limited to parts of the north coast of PNG, and Lae, Rabaul harbour 1982/1984. DMPGM plans to acquire hydrographic survey equipment to undertake near shore bathymetry mapping. • Topography data is held by the Lands Department (National Mapping Bureau). General 1:100,000 scale (40 m contours), some 1:50'000 scale (20 m contours), but greater resolution is desirable. • Physical Planning-Building Code exists but needs revision.

Tsunami hazard, Vulnerability, Risk and Mitigation (Continued)

Recommendations:

24. Complete comprehensive tsunami hazard analysis and mapping to enhance the warning system and identify vulnerable areas based on the tsunami catalogue, past areas of inundation, GIS data and deep ocean models to identify low-lying communities which may be prone to tsunami impacts from all likely sources. Make the information readily accessible in a user-friendly format.

25. Continue integrated all-hazard Community-Based DRM programs for at risk communities.

26. Establish a database of traditional knowledge on early warning signs and coping mechanisms, including recovery. The study should include capturing disaster stories.

27. Identify potential losses due to tsunami impacts as an advocacy and planning tool to encourage investment in tsunami risk reduction.

28. Acquire high resolution near-shore bathymetry and topography data to enable tsunami inundation modelling of major urban centres at risk as part of a multi-hazard mapping activity.

29. Investigate options for completing tsunami inundation modelling, particularly for population and infrastructure centres that are identified as being vulnerable to tsunami.

30. On completion of natural hazards (including tsunami inundation) modelling, revise the building code, at least for critical infrastructure.

5.3.9. Knowledge, Information, Public and Stakeholder Awareness and Education

Strengths:	Opportunities for Improvement:
• General slight to moderate tsunami awareness and knowledge amongst communities. This has not been formally assessed. • Ongoing awareness programmes and activities, including media campaigns, are conducted by a number of agencies, with a number of donor funds and some agency budget funds. • Disaster education information, including tsunami, is included in the phone book (D14). • "The Aitape Tsunami Three Years On" (D10) was a travelling exhibition on the third anniversary of the disaster which was run in 2001 – 2002 by the PNG National Museum and Art Gallery (with funding and contributions from various sources). No other tsunami museums or memorials were identified. • "Dangerous Volcano's of PNG" (D9) is an educational resource on the 14 to 17 PNG volcano's that have been active in the last 150 years (in English and Pidgin). Included in this education pack is the possibility of tsunami as a result of a volcanic eruption. • Educational posters exist for tsunami (D11a) and volcanoes (D11b to D11j). • Training needs analysis is being undertaken. The Red Cross has assessed the capacity and training needs in their branches as basis to design Community-Based DRM program. • The UPNG takes a key role in community education and disaster management training in PNG. Their Geology and Disaster Reduction course includes tsunami (see D28 for the course outline). • "Geology and Disaster Reduction Workbook" exists (2006, D7) created by UPNG (Hugh Davis). The workbook covers disaster reduction and management in PNG including hazards such as volcanoes, earthquakes and tsunami. The workbook is in a PNG context throughout. • "disaster! Reducing the effect of natural hazards in PNG and the South west Pacific" (2006, D8) is the recommended text for UPNG Course 1.10502 Geology and Disaster Reduction. It includes tsunami. • The National Disaster Management Plan (1987, D13) has aims for reducing community vulnerability, including public awareness, understanding the nature of warnings and what actions to take etc.	• Lack of effective awareness in communities. • No structured awareness program ad hoc initiatives after/during disasters, partly together with other geo-hazards. • Inconsistent training (funding limited). • Distribution of tsunami educational material (for example, posters) is limited. • No media training programs for the media on tsunami or other hazards. • Although elements of natural hazards are included in natural sciences curricula in schools, preparedness is not taught. NDC is engaging with the Education Department to do so in the future. • Provincial assessments of disaster preparedness and emergency response capabilities as well as training have been conducted in Emergency Operations Centre (EOC). However, a lack of funds and commitment from Provinces has delayed further action. • Preparedness and Public Awareness Sub-Committee exists, but have been inactive.

Knowledge, Information, Public and Stakeholder Awareness and Education (Continued)	
Strengths:	**Opportunities for Improvement:**
• According to the National Disaster Management Plan (1987, D13) a National Disaster Committee is also the Training Committee. A National Disaster Plan Training Officer and an Executive Committee (Training committee + persons from public life and training institutions) for training are also established under this plan. The plan also calls on Departments and Agencies to be responsible for training of their own staff to meet responsibilities as well as appointing a Training Liaison Officer.	• (Refer above)

Recommendations:

31. Further develop and enhance the current awareness media campaigns.

32. Appoint a "public information officer" with responsibility to develop and enhance a multi-hazard awareness campaign at the community level.

33. Integrate the disaster awareness initiative, including tsunami, throughout all levels of the education curriculum. Ensure this includes natural warning signs for tsunami and action that should be taken by communities in response to these signs or receiving a warning from authorities.

34. Identify training needs by completion of a training needs analysis and development of a national training strategy for DRM in PNG (including a database to track progress).

35. Introduce a competency-based training approach to the development of skills and knowledge in the field of DRM across key government agencies. This should include development of a tsunami competency-based training program for the operational staff of key agencies to reflect tsunami operational practices as outlined in developed SOPs.

5.4. Additional Workshop Benefits

In addition to this report, benefits of the tsunami capacity assessment workshop in PNG were:

- Improved understanding and documentation of capacity in PNG to receive and respond to tsunami warnings;
- Enhanced working relationships with counterparts and associated agencies and organisations;
- Exchanged information on respective activities and capabilities;
- Provision of some spare computer equipment from the University of Guam to the NWS to repair failing laptops;
- Open exchange of information on community awareness and preparedness planning as well as implementation and emergency response amongst workshop participants; and
- Enhanced working relationships between the Papua New Guinea participants, the Bureau, AGD, SOPAC and the University of Guam.

5.5. Next Steps

PNG will receive three key material outcomes from the Tsunami Capacity Assessment project:

1. The completed questionnaire in electronic format with scanned copies of all supporting documentation collected in-country;
2. A comprehensive National Report in a standard format which aims to summaries information collected from the visits and is consumable for non-technically minded recipients (this document); and
3. A copy of the final Regional Report which will outline common themes across the region.

At the agreement of the country project results will be posted on websites such as the Bureau and Pacific Disaster Net.

Once approved by the country the Bureau will facilitate dissemination of reports to regional and international donors and other stakeholders to ensure maximum exposure of results. Contingent on the availability of human and financial resources, 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 based on the results of this project.

Section 6

6. Annexure

6. Annexure

6.1. Annexure 1: Record of Participants at Workshop October 2008

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Geohazard Management (DMPGM)	Director	Mr	Joe	Buleka	Private Mail Bag Port Moresby PO, NCD, PNG	+675 3212422	+675 3211360	Joe_buleka@mineral.gov.pg
Port Moresby Geophysical Observatory	Assistant Director	Mr	Chris	McKee	Private Mail Bag Port Moresby PO, NCD, PNG	+675 3214500		pmgo@daltron.com.pg
Rabaul Volcano Observatory	Assistant Director	Mr	Ima	Itikarai	PO Box 386 Rabaul, East New Britain Province PNG	+675 9821699	+675 9821004	hguria@global.net.pg
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Organisation	Position	Title	First Name	Last Name	Postal Address	Telephone	Fax	E-mail
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6.2. Annexure 2: The Visiting Assessment Team

Team Position	Name	Position within Organisation	Organisation	Contact Details
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Data Communications Expert	Bruce Best	Research Associate and Station Manager for the Pacific PEACESAT Project: TADEO	University of Guam for the Australian Bureau of Meteorology	bbest@guam.net Ph. 1 671 735 2620 Mob. 671 688 5301
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6.3. Annexure 3: Agenda, PNG Tsunami Capacity Assessment Workshop

National Capacity Assessment of Papua New Guinea's Tsunami Warning and Mitigation System

WORKSHOP AGENDA 21 – 24 October 2008

DAY 1: Tuesday 21st October 2008

SESSION 1: OPENING CEREMONY AND INTRODUCTORY PRESENTATIONS

LOCATION: Hideaway Hotel, Morea Tobo Street, Port Moresby

CHAIR: Gordon Jackson, Team Leader, Visiting Assessment Team

Time	Item	Questionnaire Reference	Duration	Participation
9.00 – 9.30am	**Welcome Address** • *MC – Jimmy Gomoga, Assistant Director (FWC)* • *PNG Representative – Mr.Manasupe Z Zurenuoc, OBE Secretary of the Department of Provincial and Local Government Affairs and Chairman of the National Disaster Committee* • *Gordon Jackson – Team Leader, Visiting Assessment Team*	NA	0.5hrs	Open
9.30 – 10.00am	**Presentation –** • *Introduction to the tsunami capacity assessment project and, tsunami science* ***Presenter:*** *Gordon Jackson – Team Leader, Visiting Assessment Team*	NA	0.5hrs	Open
10.00 – 10.30am	**Opening Morning Tea**	NA	0.5hrs	Open
10.30 – 11.00am	**Presentation –** • *The tsunami hazard in relation to PNG* ***Presenter:*** *Michael Bonte – Risk Assessment Specialist, SOPAC*	NA	0.5hrs	Open

Time	Item	Questionnaire Reference	Duration	Participation
11.00 – 12.30pm	**Presentations –** • *PNG Tsunami Monitoring, Mitigation & Management System* ***Presenter:*** *Mr. Samuel Maiha – Assistant Director, Climate & Support Services)* • *Geophysical Observatory and Monitoring & Historical Tsunami in New Guinea and Solomon Islands* ***Presenter:*** *Mr. Mathew Moihoi – Principal Geophysicist, Geophysical Observatory* • *Tsunami Warning, Coordination and Mitigation* ***Presenter:*** *Mr. Manasupe Zurenuoc – Chairman, National Disaster Committee*	**NA**	**1.5hrs**	**Open**
12.30 – 1.30pm	**Lunch**	**NA**	**1hr**	**Open**

SESSION 2: ORGANISATIONS, COMMITTEES, LEGISLATION, STRATEGY AND COOPERATION				
LOCATION: Hideaway Hotel, Morea Tobo Street, Port Moresby				
CHAIR: Gordon Jackson, Team Leader, Visiting Assessment Team				
1.30 – 2.30pm	***Focus Groups*** • *PNG's priorities for implementing an effective tsunami warning and mitigation system*	*Section 4*	*1hr*	*Open*
2.30 – 3.30pm	**Capacity Assessment – Organisations, Committees and Legislation**			
	• *Organisations involved in tsunami warning and mitigation in PNG*	*Section 2, Part A*	*1hr*	*Open*
	• *Tsunami warning and mitigation coordination committees at National, and village level in PNG*	*Section 2, Part B*		
	• *Legislation relevant to tsunami warnings and emergency response*	*Section 2, Part C*		
3.30 – 4.00pm	**Afternoon tea**	**NA**	**0.5hrs**	**Open**
Time	**Item**	**Questionnaire Reference**	**Duration**	**Participation**
4.00 – 5.00pm	**Capacity Assessment – Strategy, International and Regional Cooperation, All Hazards Approach**			
	• *Disaster risk reduction strategy in PNG*	*Section 2, Part D*	*1hr*	*Open*
	• *International and Regional cooperation for tsunami warning and mitigation in PNG*	*Section 2, Part E & F*		
	• *All-hazards approach*	*Section 3*		
5.00pm	**CLOSE**			

DAY 2: Wednesday 22nd October 2008

SESSION 3: RESEARCH, MONITORING AND WARNING

LOCATION: Hideaway Hotel, Morea Tobo Street, Port Moresby

CHAIR: Gordon Jackson, Team Leader, Visiting Assessment Team

Time	Item	Questionnaire Reference	Duration	Participation
9.00 – 9.30am	**Opening Presentation:** • *Tsunami Warnings & Communication* ***Presenters:*** *Gordon Jackson & Bruce Best*	**NA**	**0.5hrs**	**Open**
9.30 – 11.30am	**Capacity Assessment – Research, Monitoring, Warning and Emergency Response**			
9.30 – 10.00am	***Research and development expertise***	*Section 5*	*0.5hr*	*Open*
10.00 – 10.30am	***Tsunami monitoring including:*** • *Tsunami monitoring infrastructure (seismic network, sea-level network and utilisation of satellites for data communication)* • *Case Study – Use of this monitoring infrastructure for the 1 April 2007 Solomon Islands Event*	*Section 6, Part A, B, C & Case Study – Monitoring Systems*	*0.5hrs*	*Open*
10.30 – 11.00am	**Morning Tea**	**NA**	**0.5hrs**	**Open**
11.00 – 1.00pm	***Tsunami warning system in PNG including:*** • *International communication cooperation* • *National tsunami warning centre* • *Receipt of advisories from PTWS* • *Procedures for dissemination of tsunami warnings Nationally, once received from PTWS*	*Section 7, Part A, B, C, D, E, F, G, Case Study – Tsunami Advisory Messages and Warnings & Part H*	*2hrs*	*Open*

Time	Item	Questionnaire Reference	Duration	Participation
	Tsunami warning system in PNG <u>continued</u> including: • *Issuing warnings for marine vessels, harbours and ports* • *Case Study – Receipt of international advisories and dissemination of warnings nationally for the 1 April 2007 Solomon Islands Event* • *CONCLUSION – Strengths and weaknesses of tsunami warnings*	*As above*	*As above*	*As above*
1.00 – 1.30pm	**Lunch**	**NA**	**0.5hr**	**Open**
SESSION 4: SITE TOURS				
LOCATION: PNG National Weather Service, National Disaster Centre and Geophysical Observatory				
CHAIR: National Weather Service, National Disaster Centre & Geophysical Observatory				
1.30 – 5.00pm	• Geophysical Observatory • PNG National Weather Service • National Disaster Centre	NA	3.5hrs	Relevant Agencies & Assessment Team

DAY 3: Thursday 23rd October 2008

SESSION 5: TSUNAMI EMERGENCY RESPONSE, MITIGATION AND PREPAREDNESS

LOCATION: Hideaway Hotel, Morea Tobo Street, Port Moresby

CHAIR: Gordon Jackson, Team Leader, Visiting Assessment Team

Time	Item	Questionnaire Reference	Duration	Participation
9.00 – 9.30am	**Opening Presentation:** • *Emergency Coordination and Planning, Community Awareness* ***Presenter:*** *Steve Banks, EMA*	NA	0.5hrs	Open
9.30 – 10.30am	**Emergency response to tsunami in PNG** • *Assessing the capacity of the disaster management system in PNG and identifying training needs* • *Emergency response and recovery plans* • *Evacuation (including evacuation legislation)*	Section 8, Part A, B & C	1hr	Open
10.30 – 11.00am	**Morning Tea**	NA	0.5hrs	Open
11.00 – 12.30pm	**Emergency response to tsunami in PNG <u>continued</u> including:** • *GIS use for emergency response* • *Testing and exercising* • *Consideration of critical infrastructure* • *Tsunami mitigation efforts* • *The role of NGOs in tsunami warning and mitigation* • *Case Study – Preparedness and response for the 1 April 2007 Solomon Islands Event*	Section 8, Part D, E, F, G, H & Case Study – Preparedness and Response	1.5hrs	Open
12.30 – 1.30pm	**Lunch**	NA	1hr	Open

Time	Item	Questionnaire Reference	Duration	Participation
SESSION 6: TSUNAMI HAZARD, VULNERABILITY, RISK AND COMMUNITY AWARENESS				
1.30 – 5.00pm	**Capacity Assessment – Hazard, Vulnerability, Risk and Community Awareness**			
1.30 – 2.30pm	***Tsunami hazard, vulnerability and risk studies in PNG including:*** • *Post tsunami surveys* • *Tsunami hazard, vulnerability and numerical modelling studies* • *Community participation in assessing the tsunami risk*	*Section 9, Part A, B, C, D, E, F*	*1hr*	*Open*
2.30 – 3.00pm	**Afternoon Tea**	**NA**	**0.5hrs**	**Open**
3.00 – 5.00pm	***Public and stakeholder awareness and education regarding tsunami in PNG including:*** • *Assessment of public awareness* • *The role of public awareness in understanding warnings and taking action* • *Public awareness and education programs* • *Media education programs* • *Tsunami memorials and museums*	*Section 10, Part A, B, C, D*	*2hrs*	*Open*
5.00pm	**CLOSE**			

DAY 4: Friday 24th October 2008

SESSION 6: PRESENTATION OF PRELIMINARY ASSESSMENT FINDINGS

LOCATION: Hideaway Hotel, Morea Tobo Street, Port Moresby

CHAIR: Gordon Jackson, Team Leader, Visiting Assessment Team

Time	Item	Questionnaire Reference	Duration	Participation
10.00 – 11.00am	**Preliminary summary presentation** • *PNG's strengths, needs, preliminary recommendations, priority review and next steps* ***Presenter:*** *Gordon Jackson – Team Leader* **Questions and Feedback** *From PNG participants on preliminary summary presentation and the assessment process in general*	**NA**	**1hr**	**Open**
11.00 – 11.30am	**ACKNOWLEDGEMENTS AND CLOSE** **MORNING TEA**	**NA**	**0.5hrs**	**Open**

6.4. Annexure 4: Supporting Documents Log

Ref.	Document Name	Copy Obtained (Y/N)	Format (H=Hard Copy) (E=Electronic)
D1	Tsunami, PNG 1998 Extracts from Earth Talk, Hugh Davies	Y	H
D2	Final NWS tsunami warning issued for April 2007 Solomon Island event	Y	E
D3	PTWC Tsunami Bulletin No.4 as relayed by NWS and upon which D2 is based.	Y	E
D4	NWS tsunami dissemination address list.	Y	E
D5	PNG Red Cross Society Disaster Preparedness & Response Plan, March 2002. (note – reviewed version expected to be issued early 2009)	Y	H
D6	Aitape Story, Second draft to report on the Aitape tsunami of 1998, Hugh L Davis 2008.	N	NA
D7	Geology and Disaster Reduction Workbook, Hugh L. Davis, UPNG, 2006	Y	E
D8	Disaster! Reducing the effect of natural hazards in PNG and SW Pacific	Y	E
D9	Dangerous volcanoes of PNG, public education folder indicating dangers associate with volcanoes including tsunamis	Y	H
D10	The Aitape Tsunami three years on, booklet from commemorative exhibit held at the PNG National Museum & Art Gallery, July 1998	Y	H

Ref.	Document Name	Copy Obtained (Y/N)	Format (H=Hard Copy) (E=Electronic)
D11	Posters produced for tsunami and volcano education and awareness **a.** Tsunami warning signs **b.** PNG Volcanoes and Disasters **c.** Plate Tectonics & Volcanoes **d.** PNG Types of Volcanoes **e.** PNG Types of Eruptions **f.** Volcanic Hazards & Reducing Disasters **g.** High Risk Volcanoes **h.** PNG Monitoring Volcanoes 1 **i.** PNG Monitoring Volcanoes 2 **j.** Who we are, what we do: RVO	Y	H
D12	Disaster Management Act (Chapter 403), 2004	Y	E
D13	Disaster Management Plan, Jan 1987	Y	H
D14	Extract from Telikom directory showing Disaster awareness and education	Y	E
D15	Map of telecommunication network of PNG indicating Exchanges, Switching Units, Repeaters, Base Stations and Bearers	Y	E
D16	Telikom IDR & DAMA Trunk System Architecture	Y	E
D17	Manus Island Tide Gauge Upgrade Report. April 2007	Y	E
D18	The Pacific Plan, Pacific Islands Forum 2005, Pacific leader's vision for development of the Pacific region.	Y	E
D19	Thirty-Ninth Pacific Islands Forum, Alofi, Niue, 19–20 August 2008, Forum Communiqué	Y	E
D20	Dengler, L. & Preuss, J. (2003): Mitigation Lessons from the July 17, 1998 Papua New Guinea Tsunami – in: Pure appl. Geophys. 160 p. 2001–2031.	Y	E
D21	Anton, L. & McKee, C.O. (2005): The Great Earthquake of 16 November 2000 and associated Seismo-Tectonic Events near the Pacific-Solomon-South Bismarck Plate Triple Junction in Papua New Guinea – PNG Geological Survey Report 2005/1	Y	E
D22	Anton, L. & McKee, C.O. (2005): Tectonic Significance of the Magnitude 7.8 Wewak Earthquake of September 2002 – PNG Geological Survey Report 2005/2	Y	E

Ref.	Document Name	Copy Obtained (Y/N)	Format (H=Hard Copy) (E=Electronic)
D23	Ripper, I.D. et al (2000): Preliminary account of the scientific investigations of the 17 July 1998 Sissano Lagoon (Aitape) Tsunami – PNG Geological Survey Report 2000/1.	Y	E
D24	Ripper, I.D. & Letz, H. (1999): The Sissano Lagoon (Aitape) Tsunami: Which Earthquake was Responsible?– PNG Geological Survey Report 1999/7.	Y	E
D25	Ripper, I.D. et al. (1999). Felt Effects of the 17 July 1998 Sissano Lagoon Tsunami Earthquakes – PNG Geological Survey Report 1999/13.	Y	E
D26	EVERINGHAM, I. B. (1977), Preliminary Catalogue of Tsunamis for the New Guinea/Solomon Islands Region 1768–1972, Australian Bureau of Mineral Resources, Report 180	N	NA
D27	PMGO- EQ database	N	NA
D28	Course outline for the Geology and Disaster Reduction course, 1.10502, offered by UPNG.	Y	E
D29	Extract from Telikom directory showing Safety at Sea awareness and education	Y	E
D30	SMEC International risk assessment, technical feasibility, planning and subsequent design and documentation for the reoccupation and restoration of Rabaul Town.	Y	E
D31	NDC Situation Report issued 2 April on 2007 Solomon Island EQ and Tsunami	Y	E
D32	NDC Situation Report issued 3 April on 2007 Solomon Island EQ and Tsunami	Y	E
D33	NDC Situation Report issued 8 April on 2007 Solomon Island EQ and Tsunami	Y	E
D34	Report to ADRC, Kobe 2001 on PNG Tsunami Project	Y	E
D35	Brief to NDC Director on Tsunami Warning Mechanisms in PNG	Y	E
D36	NDC media release on “false” tsunami 8 Feb. 2005	Y	E
D37	National Disaster Mitigation Policy	Y	E
D38	Volcano Collapse and tsunami generation in the Bismarck Volcanic Arc, PNG (Silver et al, 2009)	Y	E
D39	Ripper, I.D. (1979). Seismicity and Tsunami Warning in Papua New Guinea	Y	E

Ref.	Document Name	Copy Obtained (Y/N)	Format (H=Hard Copy) (E=Electronic)
D40	Ripper, I.D. (1979). Large Earthquakes and Seismic Zones of the New Guinea Region	Y	E
D41	P.L. Lowenstein and B. Talai (1984). Volcanoes and Volcanic Hazards in Papua New Guinea	Y	E
D42	I.D. Ripper and H. Letz (1991). Distribution and Origin of Large Earthquakes in the Papua New Guinea Region, 1900 – 1989.	Y	E
D43	I.D. Ripper, H. Letz and M. Moihoi (1998). Pre-tsunami large earthquakes of the Aitape region north coast mainland of Papua New Guinea.	Y	E
D44	Steven N. Ward and Simon Day (2003). Ritter Island Volcano – lateral collapse and the tsunami of 1888.	Y	E
D45	RW Johnson (1987). Large-scale volcanic cone collapse: the 1888 slope failure of Ritter volcano, and other examples from Papua New Guinea	Y	E
D46	Papua New Guinea Technical Report. High-Resolution Bathymetric Survey. Fieldwork undertaken from 28 May to 15 June 2006. EU-SOPAC Project Report 115 (October 2008). Reducing Vulnerability of Pacific ACP States.	Y	E
D47	Tsunami risk from volcanic collapse. Sunday Chronicle, Sunday 14 March 2010.	Y	E

6.5. Annexure 5: Definitions

Used in reports for SOPAC Member Countries National Capacity Assessment: Tsunami Warning and Mitigation Systems

Source: United Nations, International Strategy for Disaster Reduction, 2009

Capacity

A combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster.

Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity may also be described as capability.

Capacity building

Efforts aimed to develop human skills or societal infrastructures within a community or organization needed to reduce the level of risk.

In extended understanding, capacity building also includes development of institutional, financial, political and other resources, such as technology at different levels and sectors of the society.

Disaster

A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources.
A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk.

Disaster risk management

The systematic process of using administrative decisions, organization, operational skills and capacities to implement policies, strategies and coping capacities of the society and communities to lessen the impacts of natural hazards and related environmental and technological disasters. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards.

Disaster risk reduction (disaster reduction)

The reduction of disaster risks and adverse impacts of natural hazards, through systematic efforts to analyse and manage the causes of disasters, including through avoidance of hazards, reduced social and economic vulnerability to hazards, and improved preparedness for adverse events

Early warning

The provision of timely and effective information, through identified institutions, that allow individuals exposed to a hazard, to take action to avoid or reduce their risk and prepare for effective response.

Early warning systems include of three primary elements: (i) forecasting of impending events; (ii) processing and dissemination of warnings to political authorities and population; and (iii) undertaking appropriate and timely actions.

Emergency management

The organization and management of resources and responsibilities for dealing with all aspects of emergencies, in particularly preparedness, response and rehabilitation.
Emergency management involves plans, structures and arrangements established to engage the normal endeavours of government, voluntary and private agencies in a comprehensive and coordinated way to respond to the whole spectrum of emergency needs. This is also known as disaster management.

Geographic information systems (GIS)

Analysis that combine relational databases with spatial interpretation and outputs often in form of maps. A more elaborate definition is that of computer programmes for capturing, storing, checking, integrating, analysing and displaying data about the earth that is spatially referenced.
Geographical information systems are increasingly being utilised for hazard and vulnerability mapping and analysis, as well as for the application of disaster risk management measures.

Hazard

A potentially damaging physical event, phenomenon and/or human activity, which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

Hazards can include latent conditions that may represent future threats and can have different origins: natural (geological, hydrometeorological and biological) and/or induced by human processes (environmental degradation and technological hazards). Hazards can be single, sequential or combined in their origin and effects. Each hazard is characterised by its location, intensity, frequency and probability.

Land-use planning

Branch of physical and socio-economic planning that determines the means and assesses the values or limitations of various options in which land is to be utilized, with the corresponding effects on different segments of the population or interests of a community taken into account in resulting decisions.

Land-use planning involves studies and mapping, analysis of environmental and hazard data, formulation of alternative land-use decisions and design of a long-range plan for different geographical and administrative scales.

Land-use planning can help to mitigate disasters and reduce risks by discouraging high-density settlements and construction of key installations in hazard-prone areas, control of population density and expansion, and in the siting of service routes for transport, power, water, sewage and other critical facilities.

Mitigation

Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards.

Natural hazards

Natural processes or phenomena occurring in the biosphere that may constitute a damaging event.
Natural hazards can be classified by origin namely: geological, hydrometeorological or biological. Hazardous events can vary in magnitude or intensity, frequency, duration, area of extent, speed of onset, spatial dispersion and temporal spacing.

Preparedness

Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary removal of people and property from a threatened location.

Prevention

Activities to provide outright avoidance of the adverse impact of hazards and means to minimize related environmental, technological and biological disasters.

Depending on social and technical feasibility and cost/benefit considerations, investing in preventive measures is justified in areas frequently affected by disasters. In the context of public awareness and education, related to disaster risk reduction changing attitudes and behaviour contribute to promoting a "culture of prevention".

Public awareness

The processes of informing the general population, increasing levels of consciousness about risks and how people can act to reduce their exposure to hazards. This is particularly important for public officials in fulfilling their responsibilities to save lives and property in the event of a disaster.
Public awareness activities support changes in behaviour leading towards a culture of prevention. This involves public information, dissemination, education, radio or television broadcasts and the use of printed media, as well as, the establishment of information centres and networks and community and participation actions.

Recovery

Decisions and actions taken after a disaster with a view to restoring or improving the pre-disaster living conditions of the stricken community, while encouraging and facilitating necessary adjustments to reduce disaster risk.

Recovery (rehabilitation and reconstruction) affords an opportunity to develop and apply disaster risk reduction measures.

Relief / response

The provision of assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected. It can be of an immediate, short-term, or protracted duration.

Resilience / resilient

The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.

Risk

The probability of harmful consequences, or expected losses (deaths, injuries, property, livelihoods, economic activity disrupted or environment damaged) resulting from interactions between natural or human induced hazards and vulnerable conditions.

Conventionally risk is expressed by the notation
Risk = Hazards x Vulnerability
Some disciplines also include the concept of exposure to refer particularly to the physical aspects of vulnerability.

Beyond expressing a possibility of physical harm, it is crucial to recognize that risks are inherent or can be created or exist within social systems. It is important to consider the social contexts in which risks occur and that people therefore do not necessarily share the same perceptions of risk and their underlying causes.

Risk assessment/analysis

A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend.

The process of conducting a risk assessment is based on a review of both the technical features of hazards such as their location, intensity, frequency and probability; and also the analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios.

Structural / non-structural measures

Structural measures refer to any physical construction to reduce or avoid possible impacts of hazards, which include engineering measures and construction of hazard-resistant and protective structures and infrastructure.

Non-structural measures refer to policies, awareness, knowledge development, public commitment, and methods and operating practices, including participatory mechanisms and the provision of information, which can reduce risk and related impacts.

Vulnerability

A set of conditions and processes resulting from physical, social, economic, and environmental factors, which increase the susceptibility of a community to the impact of hazards.

6.6. Annexure 6: References

- Australian Agency for International Development (AusAID) and Australian Bureau of Meteorology 2006, *Schedule 5 to the Record of Understanding 14304 in relation to cooperation between the Australian Bureau of Meteorology and AusAID for SOPAC Member Countries National Capacity Assessment: Tsunami Warning and Mitigation Systems,* AusAID, Canberra.

- Everingham, I. B. (1977), Preliminary Catalogue of Tsunamis for the New Guinea/Solomon Islands Region 1768–1972, Australian Bureau of Mineral Resources, Report 180

- Greenslade, D.J.M., Simanjuntak, M.A. and S.C.R. Allen (2009). An Enhanced Tsunami Scenario Database: T2, *CAWCR Technical Report No. 14.* Bureau of Meteorology, Australia.

- Intergovernmental Oceanographic Commission, a division of the United Nations Educational, Scientific and Cultural Organisation, *Assessment of Capacity Building Requirements or an Effective and Durable Tsunami Warning and Mitigation System in the Indian Ocean, Consolidated Report for Countries Affected by the 26 December 2004 Tsunami,* viewed 2008, <http://www.ioc-tsunami.org/index.php?Itemid=978&id=275&option=com_content&task=view>

- IOC's Tsunami Program, Intergovernmental Coordination Group for the Pacific Tsunami Warning System (ICG/PTWS), International Tsunami Information Centre October, viewed January 2009, <http://ioc3.unesco.org/itic/contents.php?id=179>

- Pacific Tsunami Warning Center 2008, National Oceanographic and Atmospheric Administration (NOAA), U.S.A, viewed January, 2009, <http://www.prh.noaa.gov/ptwc>

- PNG Country Brief – October 2009, Australian Department of Foreign Affairs and Trade, Canberra, viewed July, 2009, < http://www.dfat.gov.au/geo/png/png_brief.html>

- Thomas, C. and Burbidge, D. 2009. A Probabilistic Tsunami Hazard Assessment of the Southwest Pacific Nations. *Geoscience Australia Professional Opinion No. 2009/02.*

- Thomas, C., Burbidge, D., Cummings, P., 2007. *A Preliminary study into the Tsunami Hazard faced by Southwest Pacific Nations*. Risk and Impact Analysis Group, Geoscience Australia.

- Terminology: Basic terms of disaster risk reduction March 2004, United Nations, International Strategy for Disaster Reduction, viewed January, 2007, <http://www.unisdr.org/eng/library/lib-terminology-eng%20home.htm>

Note: Also refer to *Annexure 4: Supporting Documents Log*

6.7. Annexure 7: Additional Data Communications Notes by Bruce Best

NWS Port Moresby (field trip notes)

The Weather station is functional and pivotal in any emergency /disaster situation (open 24/7), has HF radio/fax/internet circuits. The NWS station's HF network is working, although not data ready. The office has a back up HF radio and can broadcast emergency information to the Port Moresby port radio and to any Health/religious HF radio network stations that are monitoring: The Icom 78 (has one of Bryan Hodge's SCS PTC //ex RF modems attached but not functioning) and Icom M700 radios are tuned to 7898.5 KHz USB.

Note: All PNG HF networks need to know that the Port Moresby NWS is monitoring 7898.5 KHz 24 hrs a day so that vital earthquake and emergency traffic can get to first responders through the NWS office. We noted communication was non-existent after the 1998 Aitape disaster and the NWS office communication links can save many lives in the future.

The EMWIN at Port Moresby NWS is working on the American GOES system. They office property hosts two international transmitters for radiation data (one going to Vienna and one to America) and their ICIS never functioned. RANET /WORLDSPACE is not functioning but the unit is hooked up.

The Japanese put a fibre ring to the airport that transmits the aviation data. The compound is fenced with barbed wire and a guard. Jimmy is operations manager and Tau Ray Giabi is head of Observations and Samual Maiha covers the climate section.

Note : Bruce Best sent Jimmy four used laptops to use for parts (Jimmy has been trying to repair Dell Laptops and needs parts).

NDC office (field trip notes)

The National Disaster Centre's communication capabilities include functional VHF and HF radio systems. Currently the office is manned only during regular business hours (M-F, 8 to 5). Under the communication officer, Andrew Daego, the office supports a Barrett 2050 HF radio and monitors 7408.0 KHz USB. NDC also monitors marine VHF channel 84 on an Icom M304 marine 25 watt base station and supports a UHF repeater network for the local Port Moresby area.

There was no radio operator monitoring at the time of our visit. While he was there Bruce Best instructed Andrew on how to monitor channel 16 (international emergency channel on the marine VHF band) while listening to his working channel 84.

General Communication Comments:

1 A training and education campaign that would highlight and enhance the existing network for Port Moresby (get a VHF base installed at the NWS, since it is the only 24/7 office that is equipped with HF/Fax and data links). Educate all health, religious and government HF/VHF capable networks to the fact that the NWS is monitoring a HF/VHF channel.

2 To be of value in a disaster, all office radios must have the volume up with an operator nearby monitoring. Aitape operators called over HF channels for hours with no response.

3 Consider installing a solar powered pole mounted Irridium based RANET beetle type emergency wake-up transceivers in as many remote village centres as economics make possible. These radios can be triggered by the NWS offices in Port Moresby / Melbourne and will wake village leaders so they will turn on their HF radios and get early tsunami/cyclone warnings.

4 Budget for routine battery replacement and maintenance funds for remote emergency radio stations. Reliable communication can save lives.

6.8. Annexure 8: Priorities for improvement in PNG's tsunami warning and mitigation system as identified by participants

Priorities for PNG's tsunami warning and mitigation system were discussed and recorded in the Tsunami Capacity Assessment Workshop. These could be further formalised in DRM and tsunami plans.

Risk Assessment & Mitigation ***Gaps:*** • Incomplete or unavailable Information • Movement of evacuees – Legislation, • Codes, Regulations, • Capacity • Procedures ***Priorities:*** • Risk analysis, • Earthquake-Bathymetric database, • Availability of user-friendly information/database • Review/formulate policy documents – Enact	• Monitoring, Warning & Dissemination ***Gaps:*** • Existing national seismic network not operational • No 24/7 operations of PMGO/NDC • Inability to reach intended recipients of warning • Multi-agency coordination • Awareness & education • Priorities: • Implementation of seismic network • Restructure of PMGO (staff/resources) • Effective, reliable communication • PMGO -> NDC -> Intended recipients (ward level), media/news • Effective protocols for warning dissemination incl. all stakeholders • MOC exercise •
Response & Recovery • Local tsunami – not coordinated well	**Community Awareness** • Communication/institutional networking • More pro-active awareness • Resourcing, sustainability • Revisit Disaster Act (communications)

7. CD Attachment

7. CD Attachment - Supporting Documents

a. Assessment Questionnaire

b. Supporting Documents

c. Presentations