

TONGA

NATIONAL TSUNAMI PLAN

(DRAFT 2)

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1. INTRODUCTION

1.1 Plan Purpose

The purpose of this plan is to explain in detail the mitigation, preparedness, warning, response and recovery arrangements for tsunami event that might affect Tonga.

1.2 Plan Development and Review

This plan has been produced under the leadership of the National Tsunami Working Group and endorsed by the National Emergency Management Committee (NEMC).

The plan is to be reviewed annually and following each major tsunami event that may affect Tonga. Responsibility for the review of this plan rests with the NEMO.

1.3 Plan Context

The development of this plan is a requirement under Section 28(a) &(b) of *the Emergency Management Act 2007 and the National Emergency Management Plan 2007 (Specific Threat)*

1.4 Definitions

“**Local tsunamis**” refer to tsunami from a nearby source within the Tonga Trench or Volcanic arc.

“**Response agency**” means the agencies which are tasked with responding to emergency situations under the Tonga Emergency Management Act 2007 and National Emergency Management Plan.

“**Response agency plan**” means the Agency’s Emergency Response & Business Continuity Plan as stipulated in Part C of the National Emergency Management Plan (NEMC)

“**Tsunami**” refers to a series of travelling waves of extremely long length generated by earthquakes occurring below or near the ocean floor, volcanic eruptions, meteorites and landslides

“**Distant or Tele-tsunamis**” refers to tsunamis originating from a far away source more than 1,000km away.

“**Tsunami Warning**” refers to confirmation that a tsunami has been generated and that a warning is in force.

“**Urgent Tsunami Warning**” refers to a warning that is in force following a felt earthquake (Magnitude 7 on the Mercalli or Magnitude 6.5 or more on the Richter Scale and 50 km or less in dept has been verified by GSU.

“**Tsunami Alert**” refers to a tsunami watch received from PTWC which is communicated between TMS, NEMO and GSU. It is intended for coordination and standby and is not communicated to the public.

“Cancellation of Warning” refers to the cancellation of a tsunami warning which has been issued earlier.

“Cancellation of Tsunami Alert” refers to the cancellation of a tsunami watch received from PTWC. It is communicated between TMS, NEMO and GSU.

“All Clear” message is issued by the National Controller through NEMO to inform people that the threat or hazard has now passed and it is safe to return home. However, all safety precautions should be taken when moving back.

1.6 Plan Objectives

This National Tsunami Plan aims to achieve the following:

- To ensure correct and timely issuance and dissemination of warnings to all threatened communities.
- To ensure all communities and response agencies are prepared and ready to respond to a tsunami event.
- To minimize the impact of tsunami hazards in Tonga
- To ensure a safe and quick recovery after a tsunami event

Methods for achieving these objectives include but not limited to:

- Fulfillment of roles and responsibilities outlined in this Plan and the national Emergency Management Plan 2007
- Agreed strategies, activities and programmes at all levels
- Response agency plans and activities
- Community-based programmes supported by response agencies
- Frequent and constant simulations or exercises

Achievement of these objectives is to be monitored by the NEMO in collaboration with the NEMC. Monitoring findings are to be reported to the NEMC to facilitate its decisions for improvements to the plan and its requirements.

2. TSUNAMI RISK PROFILE

2.1 Tsunami Risk in Tonga

Tsunami risk in Tonga is rated as “extreme”. This is because Tonga lies about 200km west of the Tonga Trench fault zone, where the Pacific Plate subducts beneath the Australian Plate.

Tonga Trench and Volcanic arc are potential sources for a fault or undersea landslide caused by an earthquake or volcanic eruption, which could generate a tsunami.

By and large, the main areas at risk of a tsunami are all low-lying coastal areas of the inhabited islands of Tonga.

2.2 Historical Tsunami that affected Tonga

Historical accounts show that some 20 tsunamis have affected many islands in Tonga. An earthquake in 1919, located close to Tonga, apparently caused tsunami waves of 2.5 m in the Ha’apai Group. Three tsunami waves caused by the 1977 earthquake were recorded. More recently, the 2009 8.3 earthquake near Niua Toputapu caused a major tsunami with waves reaching 6 meters as they hit the island, resulting in 9 deaths, 60 percent of houses destroyed and extensive damage to infrastructure.

Table 21: Near-source Tsunami generating earthquake events that have affected Tonga

Year	Date	Hmax (m)	Damage ¹	Cause ²	Source	Comment
1863	24 Dec			T	Tonga, Tongatapu Island	Report of earthquake on Tongatapu with changes in land level and flooding, at night on Christmas Eve
1865	17 Nov	2		T	Tonga Islands	Reached a height of 1 m at Tau near Tongatapu, sea flooded land and washed away everything in its path
1881	24 Nov			T	Tonga Islands	On Tongatapu, land subsided, but report does not mention tsunami
1901	Fri, 9 Aug	1.2	S	T	Tonga Islands	No information on extent of damage
1908	Wed, 1 Jan			V	Tonga Islands	Several km south of Tongatapu, a submarine eruption occurred which was accompanied by a strong earthquake and tsunami (year may be 1907)
1917	Tue, 26 Jun	12	L	T	Samoa Islands (TONGA ISLANDS)	
1917	Fri, 18 Nov			T	Kermadec Islands, vicinity	Reported from Apia for earthquake origin south of Tonga
1919	Wed, 30 Apr	2.5	S	T	Tonga Islands	Tsunami 2.6 m high on Ha'apai 0.6 hr after earthquake, no comments about tsunami damage, earthquake triggered landslides in Tonga and Samoa
1926	Tue, 16 Mar			M	Tonga Islands	1 person perished and all buildings washed away (except church) on Palmerston Is, considered to be most likely a storm-generated wave
1928	Fri, 18 May			V	Tonga, Ha'apai Island	An earthquake was felt. A tsunami appeared, and pumice was cast upon the shore
1948	Wed, 8 Sep	0.1	N	T	Tonga Islands	Small Pacific-wide tsunami recorded
1968	Tue, 7 Oct			V	Tonga Islands	
1963	Wed, 18 Dec			T	Tonga Islands	Strong swell reported in Tahiti
1968	Thu, 25 Jul	0.1		T	Kermadec Islands	0.1 m tsunami recorded in Suva from earthquake in Kermadecs
1975	Fri, 26 Dec	0.75	N	T	Samoa Islands	No damage reported in Tonga
1977	Sat, 2 Apr	0.1	N	T	Tonga Trench: SAMOA ISLANDS	No damage reported in Tonga
1977	Wed, 22 Jun	0.3	N	T	Tonga Trench	No damage reported in Tonga
1977	Mon, 10 Oct	0.02	N	T	Tonga Trench	No damage reported in Tonga

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(tables to be reproduced and merged.)

Year	Date	Hmax (m)	Damage ¹	Cause ²	Source	Comment
1982	Sun, 19 Dec	0.2	N	T	Kermadec I., South of Tonga Is.	No damage reported in Tonga
1986	Mon, 20 Oct	0.2	N	T	Kermadec Islands: Raoul Is	No damage reported in Tonga
1987	Tue, 6 Oct	0.1	N	T	Tonga Islands	No damage reported in Tonga
1995	Fri, 7 Apr	0.1	N	T	Tonga, Samoa Islands	No damage reported in Tonga
1997	Tue, 14 Oct		N	T	Tonga Islands	No damage reported in Tonga

¹Damage: N = non-damaging event, S = slight damage, M = moderate damage, L = large (severe) damage,

²Cause: T = tectonic, V = volcanic, M = meteorological

2.3 Tsunami Impacts:

Tsunami is a serious threat for Tonga's socio-economic, natural and built environment given that 80% of Tonga's population and infrastructure are located on low lying coastal areas including the capital of Nukualofa, the center of commerce and economic activity.

2.3.1 Human and Social Impacts:

Due to the strength and speed of tsunami waves and their ability to cause structural damages as well as carrying debris, many people can die or become injured. For locally generated tsunamis, there is little or no time to warn the coastal communities and given that the coastal communities are located close to the shoreline any tsunami can cause mass casualties and/or fatalities.

People will also become traumatized due to the loss of life or property as well as the financial implications of reconstruction or rehabilitation. In addition, the horrific experience from a tsunami event will continue to haunt people affected over a long period of time, hence counselling will be needed during the relief and recovery period.

In worst case scenarios, village social structure can also be affected (functionally) as individuals and families will primarily focus on their own recovery from a tsunami event; it may take some time to recognize social structures within the village communities. Therefore, there will be a need to encourage and strengthen collaboration and collectiveness.

2.3.2 Impacts on the Economy and Built Environment

The major source of income for Tonga is from agriculture, fisheries and tourism. All these sectors are highly vulnerable to tsunami impact. Tsunami could also cause extensive damage to coastal infrastructures.

2.3.3 Impacts on the Natural Environment

Tonga's natural environment will also be affected by tsunamis. The beauty and the natural features of the beaches will be destroyed and the rate of coastal land erosion will increase.

3. Tsunami Risk Reduction Arrangements

Part B of the *National Emergency Management Plan 2007* sets a general framework for disaster risk reduction. This section lists the measures to reduce Tonga's risks and vulnerabilities to main hazards including tsunamis; some of these measures are currently implemented through government and non-government organizations' risk reduction programmes.

3.1 Location of development(s)

3.1.1 New development(s)

It is encouraged for all new developments that a tsunami risk analysis be carried out and appropriated mitigation measures incorporated into the design.

3.1.2 Existing development(s)

For existing developments appropriate retrofitting programmes should be considered. In addition tsunami contingency plans must be prepared for occupants and users.

3.2 Tsunami Risk Signs

Tsunami risk signs must be placed to forewarn the residents of coastal village communities and users of public infrastructure and services within the low-lying coastal areas. The NEMO, in collaboration with District and Village Emergency Management Committees are responsible for the design and installation of these signs in each coastal village community.

3.3. Evacuation Routes and Safe Places

Tsunami inundation maps must be prepared to determine high risk areas and guide the preparation of evacuation routes and identification of safe zones. The preparation of inundation map is the responsibility of the Ministry of Lands, Survey and Natural Resources.

Evacuation routes and safe zones must be clearly marked and made known to all residents of villages and users of public infrastructures and services within these coastal areas. The preparation and erection of tsunami risk signs and identification of strong and safe buildings to shelter evacuees, as well as informing residents of safe evacuation routes, is the responsibility of NEMO.

4. Preparedness Arrangements

Part C of the *National Disaster Management Plan 2007* details preparedness arrangements to be implemented at the national and community level for any disaster. The following sub-sections provide specific preparedness arrangements for tsunamis.

4.1 Public Awareness

The information on the nature of tsunamis including safety procedures will be ongoing and to be coordinated by the Community Awareness and Education Programme of NEMO.

4.2 Tsunami Early Warning System

The Tsunami Early Warning System (EWS) comprises of four steps or phases:

- 1) Detection – hazard is observed, analysed, monitored and threat assessed.
- 2) Warning – Warning message is compiled and issued.
- 3) Dissemination – Warning is disseminated through most effective means ensuring its delivery to intended recipients which generally includes the public.
- 4) Response – authorities and communities respond in expected manner to safeguard lives and properties.

4.2.1 Detection, Observation and Monitoring Network (seismic stations, dart buoys, tide gauge)

4.2.1.1 Seismic Network

Tonga has five stations in its national seismic network located in Tongatapu, Vava'u, Ha'apai and the Niua Toputapu and Niuafo'ou. The maintenance of the stations is the responsibility of Geological Services Unit (GSU of the Ministry of Lands, Survey, Natural Resources (MLSNR). The data collected from the Tonga-Fiji seismic network are analysed by GSU to determine earthquake parameters and whether a tsunami has been generated.

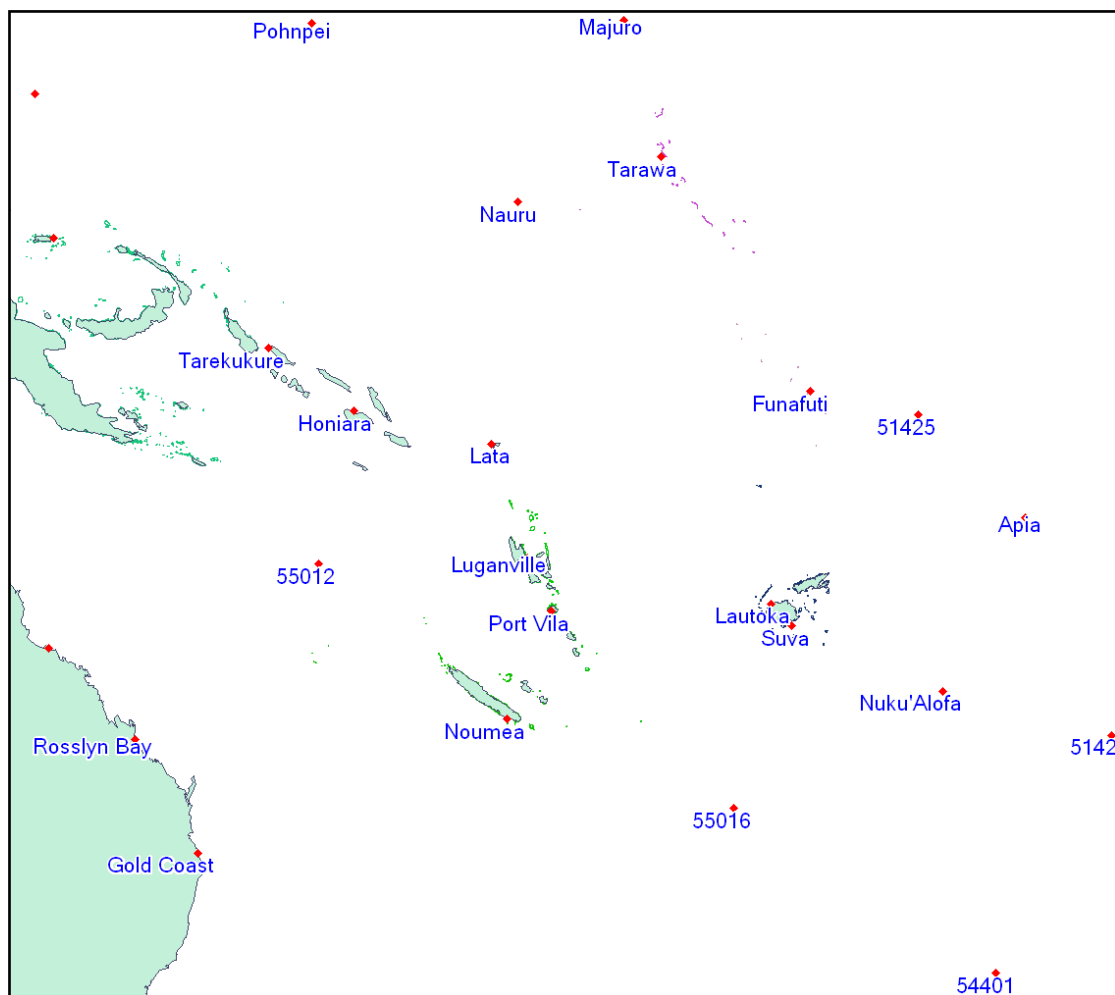
In the event of a local earthquake, GSU is responsible for providing earthquake parameters including its location, magnitude and dept to TMS and NEMO. It will also be the lead agency assessing tsunami threat for Tonga.

4.2.1.2 Tide Gauge & Dart Buoys

There is only one tide gauge located at Queen Salote Wharf. This gauge is part of the South Pacific Sea Level Rise and Climate Monitoring Project funded by AusAid. The data from this gauge goes directly to the Australian Bureau of Meteorology which in turn provides near real time data. Data can also be accessed via internet.

Three coastal gauges located in the Tonga are managed by the JATWC. These are Nukualofa, Tonga Trench (west) and South of Minerva Reef.

Figure: Coastal sea-level gauges and DARTS (as of July 2010).



4.2.2 Tsunami Warning Service for Tonga

4.2.2.1 Tsunami Warning Responsibility

The responsibility for issuing warnings to the people of Tonga lies with TMS which will perform this function in close collaboration with NEMO and GSU which will provide seismic information and advice.

4.2.2.2 PTWC Bulletins

Under the Intergovernmental Oceanographic Commission (IOC) Pacific Tsunami Warning and Mitigation System (PTWS), the Pacific Tsunami Warning Centre (PTWC) in Hawaii provides regional tsunami warning and advisory services covering all Pacific countries including Tonga. TMS is the main agency to receive the PTWC bulletins because of its 24/7 capability. However, the bulletins may be simultaneously received by NEMO and GSU.

4.2.2.3 National Tsunami Warning Centre (NTWC) Operations

As soon as a tsunami threat is imminent for Tonga, the TMS will activate the NTWC in close collaboration with GSU and NEMO.

4.2.2.3.1 Local Tsunami

When an earthquake is felt with significant shaking or there are signs of a volcanic eruption, or it causes the ocean to recede quickly, people must move to higher ground or safe zone without waiting for an official warning.

Nonetheless, the TMS will attempt to issue a warning immediately after a significant earthquake is felt (**7.0 Mercalli Scale**) or observed from the national seismic network operated by GSU. It will do the same for volcanic eruptions.

4.2.2.3.2 Regional and Tele-Tsunami

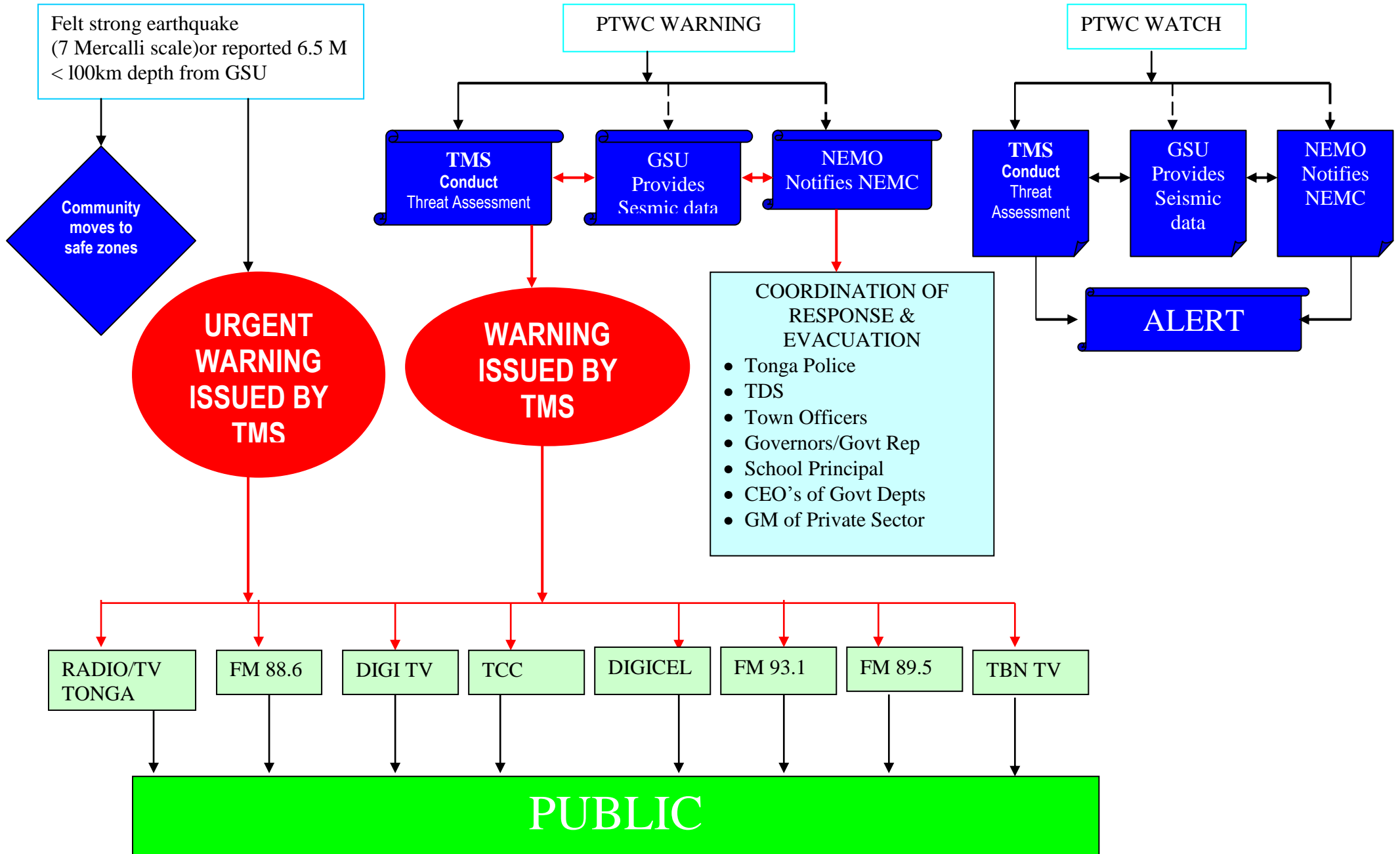
Upon receiving a PTWC bulletin that carries a “watch” or “warning” for Tonga, the TMS will make immediate contact with NEMO and GSU. They will jointly carry out an assessment of threat for Tonga and determine whether to maintain a watch or issue warning to the general public.

In the event a warning is warranted, TMS will activate the NTWC and issue the warning. NEMO will follow the warning with appropriate public advisory messages on preparedness measures and any necessary evacuation.

4.2.2.3.2 Frequency of Warnings

All warning bulletins will be generally updated and issued hourly, unless information becomes available to warrant an immediate issue.

TONGA TSUNAMI WARNING SYSTEM FLOW CHART



4.2.3 Warning Dissemination

Warnings will be disseminated by TMS through the most effective means to NEMO, GSU and the media (TV, Radio). These include -

- Facsimile,
- Email
- Website (TMS, Ministry of Information, NEMO).
- SMS by TCC and DIGICEL to pre-selected representatives in the villages which includes town officers, church ministers, school principals, hotel/motels/beach resorts representatives as well as the key personnel of responding agencies, members of the NEMC and National Disaster Council.

4.2.4 Warning Response

Response to warnings will be coordinated by NEMO which will ensure activation of siren systems and coordinate government and public response.

Upon receipt of warnings:

- Governors and Government representatives are required to activate their Island Emergency Management Committee.
- Town Officers are required to activate their Community Disaster Plan.
- Heads of Government Ministries are required to activate their Agency Response Plan.
- School Principals are required to activate their School Evacuation Plan.
- Private Sectors are required to Business Continuity Plan.

4.2.5 Tsunami Warning Cancellation

TMS will issue a “Warning Cancellation Message” upon advice from PTWC, or once it is ascertained that threat from a local tsunami is over.

4.2.6 All Clear Message

Upon receipt of “Warning Cancellation Message” from TMS, NEMO will assess the threat and situation on the ground, and will issue an “All Clear Message” advising people that they may return to their homes or place of work.

4.3 Simulations

The NEMO in collaboration with TMS and GSU will organize and conduct tsunami simulations at least once a year. The Simulations should aim at testing the following:

- Early Warning System
- Standard operational procedures
- Island, community and agency response plans
- Communication systems
- Coordination of response agencies

5. Evacuation and Sheltering

Evacuation centres should be pre-determined within the Tsunami safe zones and appropriate personnel identified to manage when activated. This may include Town Officers, District Officers, School Principals and Church Leaders.

In instances of mass evacuation from high risk areas, NEMO will enlist the services of Tonga Police and Tonga Defense Service to control movement of people and traffic to safe zones. Police will be also deployed to provide safety and security to evacuees.

All evacuees **MUST NOT** return to their homes unless an “All Clear” notice is given indicating that it is safe to return home. If the emergency period exceeds more than eight hours than food and water should be provided to the evacuees. The provision of food and water is the responsibility of the residents.

6. RECOVERY ARRANGEMENTS

After any tsunami event, the recovery provisions of the NEMP and the National Recovery Plan immediately applies.

Appendix 1: ACRONYMS

- NEMO National Emergency Management office
- PTWC Pacific Tsunami Warning Center
- USGS US Geological Survey
- NEMC National Emergency Management Committee
- MLSNRE Ministry of Lands Survey, Natural Resources and Environment
- TMS Tonga Meteorological Service
- NEMP National Emergency Management Management Plan

Appendix II(to be updated)

Table 1: Function required during a tsunami event.

Ref	Function	Lead Agency	Role	Support Agency	Role
1.	Receiving tsunami information bulletins	Meteorology Division (Ministry of Transport) GEOLOGY	Receive tsunami Information bulletin from PTWC	PTWC NEMO TCC	Provide tsunami information bulletins
2.	Calculation of local parameters and verification	Meteorology Division & Geological Unit (Ministry of Lands) (change order)	<ul style="list-style-type: none"> • Calculate local parameters • Assess threat • Determine possible impacts • Verify the information received 	PTWC USGS	Provide advice on Tsunami threat and likely impact.
3.	Issuance of Tsunami warning/watch/advisory/cancellation	Meteorological Division (Ministry of Transport) Joint TWC	<ul style="list-style-type: none"> • Contact Digicel & TCC • Prepare and issue local tsunami bulletin to media(radio/TV) 	Radio TCC NEMO A3Z	Broadcast/disseminate the Tsunami warning or watch information
4.	Alert Response Agencies and public	TMS, TCC, NEMO, Digicel Radio, TV	Send text messages, advice NEMC, National Disaster Council, District & Village Committees and Responding agencies	<ul style="list-style-type: none"> • Church Minister • School representative • Government Women Representative • Hotel/Motel/Beach Resorts • Fire & Emergency Services • Ports Authority • Airport Authority 	<ul style="list-style-type: none"> - ring church bell fast & continuous - ring school bell fast & continuous - use word of mouth to alert families & neighbors - use word of mouth to inform staff & tourists - activate siren to run continuously - activate siren continuously - carry out response functions

				<ul style="list-style-type: none">• All response agencies	
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Appendix III: Tsunami Safety Procedures and Rules

Safety Rules

1. All earthquakes do not cause tsunamis, but many do. When you hear that an earthquake has occurred or feels a strong shake from an earthquake, prepare for emergency evacuation.
2. An earthquake in your area is one of nature's tsunami warning signals. Do not stay in low-lying coastal areas after a strong earthquake has been felt.
3. Tsunami are sometimes preceded by a noticeable fall in sea level as the ocean recedes. A roar like an oncoming train may sometimes be heard as the tsunami wave rushes toward the shore. These are also nature's tsunami warning signals.
4. A tsunami is not a single wave, but a series of waves. Stay out of danger areas until an "all-clear" is issued by competent authority.
5. A small tsunami at one point on the shore can be extremely large a few kilometers away. Don't let the modest size of one make you lose respect for all.
6. All warnings to the public must be taken very seriously, even if some are for non-destructive events. The tsunami of May, 1960 killed 61 people in Hilo, Hawaii because some thought it was just another false alarm.
7. All tsunami like hurricanes are potentially dangerous, even though they may not damage every coastline they strike.
8. Never go down to the shore to watch for a tsunami. When you can see the wave you are too close to escape it. Never try to surf a tsunami; most tsunamis are like flash flood full of debris and they do not curl or break like surfing waves.
9. Sooner or later, tsunamis visit every coastline in the Pacific and other oceans. If you live in any coastal area, be prepared and know nature's tsunami warning signs.
10. During a tsunami emergency, the National Emergency Management Office, Ministry of Police and other emergency organizations will try to save your life. Give them your fullest cooperation.

Safety Procedures:

What you should do:

- If you are in school and you hear there is a tsunami warning, you should follow the advice from teachers and other school personnel.
- If you are at home and you hear there is a tsunami warning, make sure your family is aware of it. Your family should evacuate immediately if you are living in flooding zones or near the coastal areas go to higher grounds or top floor of a tall or multi-storey concrete building. Follow the advice given by the authorities to ensure your safety.

- If you are at a beach or near the ocean and you feel the earth shake or seeing a sign of water loss in the sea, move immediately to higher grounds even if you haven't heard a tsunami warning. Stay away from river banks and streams.
- Tsunami in a distance location may take sometime before it hits a specific area as its moves towards it. A local tsunami can be generated within 5-15 minute or so. It is vital to move as fast as you can to higher grounds.
- Most of tall buildings and concrete complexes are located in waterfront for better view. The upper floors can provide a safer place for refugee if you are slow to move inland that quick. This procedure is not recommended for a small and wooden buildings that sometimes would not withstand the might of the tsunami impact.
- If you are in a boat at sea move to open and deep (depth of 400m is recommended) ocean. In a local tsunami, make sure to leave your boat behind and head for higher grounds. Contact ports authorities to verify the condition before navigation and berthing

Threat: Series of destructive ocean waves can affect all shorelines. May occur with limited or no warning.

Know the terms: If a “**watch**” has been issued, tsunamis are possible; be ready. If a “**warning**” is issued, leave coastal areas immediately. If you live in low lying coastal area, you are at risk.

Take the precautions:

- Find out if your home is in the tsunami inundation zone.
- Know the height of your properties above sea level and the distance from the coast.
- Be familiar with tsunami warning signs (a sizable earthquake would trigger a tsunami).
- Tsunamis are NOT surfing waves!!!! Do not attempt to surf or ride a tsunami.
- Know your routes of escape to higher grounds or top floor of a tall or multi-storey concrete building.
- Pick a meeting location that is inland and elevated.
- Have an emergency survival kit ready.
- Have a battery operated radio on hand.

Action Plan:

- Listen to the radio/TV for the latest emergency information.
- IF you hear an official tsunami warning or detect signs of a tsunami, evacuate at once.
- Watch for a rapid and noticeable rise or fall in coastal waters as a sign of an approaching tsunami.
- Go to higher grounds or move to the top floor of tall or multi-storey concrete building.
- Do not assume that one wave means that the danger is over. The next wave may be larger than the first. Avoid returning unless an all clear warning is issued.
- Return to place/home only after authorities advise it is safe to do so.

