

**JOINT REVIEW & UPDATE OF
AGENCY SPECIFIC TSUNAMI
STANDARD OPERATING
PROCEDURES**



**Tonga MET
TSUNAMIS SOPs:
Current & Proposed**

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Contents

1

CURRENT SOP

Effective as of 01st October 2024

2

PROPOSED CHANGES TO SOP & MHEWS CONCEPT OF OPERATIONS

3

COMPETENCY ASSESSMENTS

4

OUR **WAVE** FORWARD

01



Current TMS Tsunami SOP: 01st October 2014

- **Due to operational change adopted by the UNESCO Intergovernmental Oceanographic Commission (IOC) Intergovernmental Coordination Group (ICG) for the Pacific Tsunami Warning and Mitigation System (PTWS), the Pacific Tsunami Warning Centre (PTWC) will cease issuing tsunami warnings for the Kingdom of Tonga from 0000UTC on 01 October 2014**
- **New advisory products will be issued by PTWC for the Pacific Basin based on tsunami threat**
- **Tonga Meteorological Service will employ to provide tsunami warnings for Tonga in agreement with the NEMO, the GSU and approved by the NEMC**
- **Current TMS Tsunami SOP was effective since 01st October 2014, has been 10 years now and the time is just right for the SOP to be reviewed and to be improved upon**

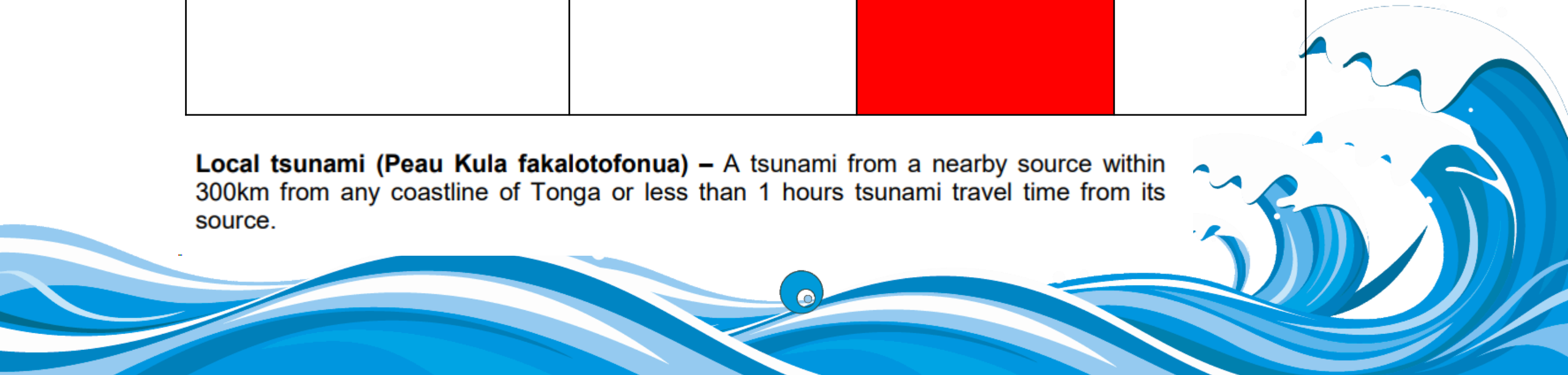
01



Current TMS Tsunami SOP: Warning for Local Source Events

Criteria	Duty Forecaster	Type of Warning/Advisory	Emergency response
(1) Earthquake 7.1≤M and <100km deep detected within 300km of Tonga's Coast or (1) Violent ground shaking observed from an unverified earthquake lasting at least 30sec	Activate and disseminate FTWCTEMPLATE1	Urgent Tsunami Warning	Evacuate tsunami threat area Turn on tsunami sirens available

Local tsunami (Peau Kula fakalotofonua) – A tsunami from a nearby source within 300km from any coastline of Tonga or less than 1 hours tsunami travel time from its source.



01



Regional tsunami (Peau Kula fakafeitu'u) – A tsunami from a regional source within 1000km to from any coastline of Tonga or tsunami travel time between 1 to 3hrs from its source.

Ocean or basin wide tsunami (Peau Kula fakamamani lahi) - A tsunami from a distant source with tsunami travel time of over 3hrs from its source.

Current TMS Tsunami SOP: Warning for Regional or Distant Source Events

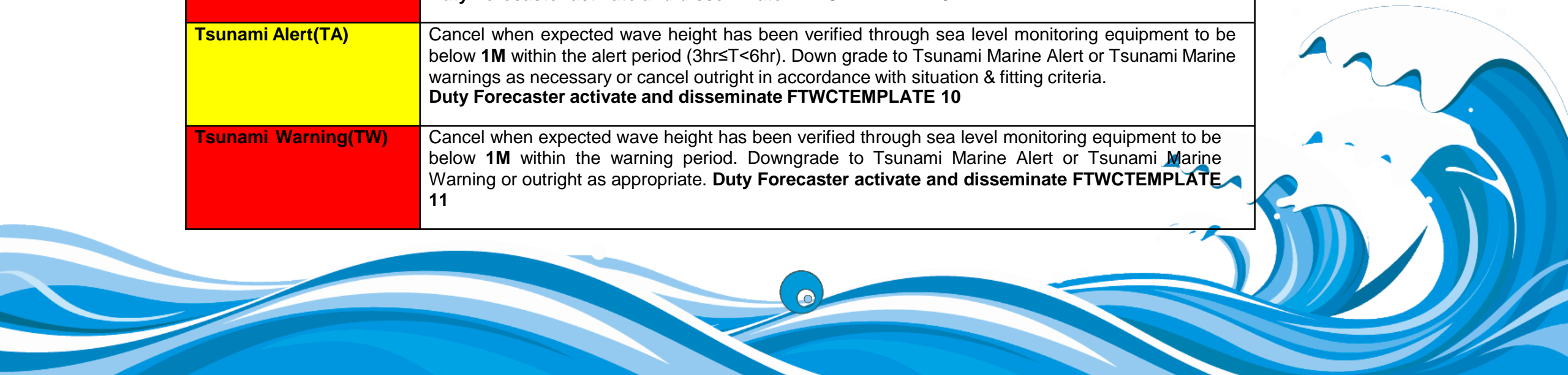
Criteria	Duty Forecaster	Type of Advisory/Alert/Warning	Emergency Response Action
Earthquake $6.5 \leq M < 7.1$ and $< 100\text{km}$ deep has been detected anywhere in the Pacific Ocean	Activate and disseminate FTWC TEMPLATE 2 to NEMC only	Significant Earthquake Advisory (SEA)	Monitor
Expected wave height $< 0.3\text{M}$ or when a tsunami or earthquake $> 7.1\text{M}$ has occurred in the Pacific Basin and assessment has been made that there is no direct threat to Tonga	Activate and disseminate FTWC TEMPLATE 3 to all outlets	Tsunami No Threat Advisory (TNTA)	Monitor
Expected wave height $0.3\text{M} \leq H < 1\text{M}$ with expected arrival time of $3\text{hr} \leq T < 6\text{hr}$	Activate and disseminate FTWC TEMPLATE 4 to all outlets	Tsunami Marine Alert (TMA)	Prepare to evacuate marine coastal area
Expected wave height $0.3\text{M} \leq H < 1\text{M}$ with expected arrival time of $< 3\text{hrs}$	Activate and disseminate FTWC TEMPLATE 5 to all outlets	Tsunami Marine Warning (TMW)	Sound Siren Evacuate coastal area
Expected wave height is $H \geq 1\text{M}$ with expected arrival time of $3\text{hr} \leq T < 6\text{hr}$	Activate and disseminate FTWC TEMPLATE 6 to all outlets	Tsunami Alert (TA)	Prepare to evacuate tsunami threat area
Expected wave height is $H \geq 1\text{M}$ with expected arrival time of $< 3\text{hrs}$	Activate and disseminate FTWC TEMPLATE 7 to all outlets	Tsunami Warning (TW)	Sound Siren Evacuate tsunami threat area

01



Current TMS Tsunami SOP: Cancellation Procedures

Alert/Warning	Cancellation criteria and templates
Tsunami MarineAlert (TMA)	Cancel when the expected wave height has been verified by sea level monitoring equipment to be below 0.3M within the alert period ($3\text{hr} \leq T < 6\text{hr}$). Downgrade to Tsunami no threat advisory as necessary or cancel outright and advice of possible strong currents remaining. Duty Forecaster activate and disseminate FTWCTEMPLATE 8
Tsunami Marine Warning (TMW)	Cancel when the expected wave height has been verified through sea level monitoring equipment to be below 0.3M within the warning period ($3\text{hr} < T$). Downgrade to Tsunami no threat advisory as necessary or cancel outright and advice of possible strong currents remaining. Duty Forecaster activate and disseminate FTWCTEMPLATE 9
Tsunami Alert(TA)	Cancel when expected wave height has been verified through sea level monitoring equipment to be below 1M within the alert period ($3\text{hr} \leq T < 6\text{hr}$). Down grade to Tsunami Marine Alert or Tsunami Marine warnings as necessary or cancel outright in accordance with situation & fitting criteria. Duty Forecaster activate and disseminate FTWCTEMPLATE 10
Tsunami Warning(TW)	Cancel when expected wave height has been verified through sea level monitoring equipment to be below 1M within the warning period. Downgrade to Tsunami Marine Alert or Tsunami Marine Warning or outright as appropriate. Duty Forecaster activate and disseminate FTWCTEMPLATE 11



02



Proposed Changes to the current TMS Tsunami SOP

- Basis for the changes will include:

- Additional Triggering mechanisms
- New tide gauge, seismic stations, travel times, focal mechanism, simulations, & Analysis tool/capabilities
- New refined criteria & warning templates
- New refined warning messages
- New criteria(s) for issuing & cancellation
- New Tsunami Impact-Based Warning Products
- NEWS Tsunami Siren System & RARs
- Current & New Dissemination Channels/Systems
- MHEWS Concept of Operations
- Alignment to Agency SOPs
- Alignment to Acts
- Alignment to National Tsunami Response Plan



02



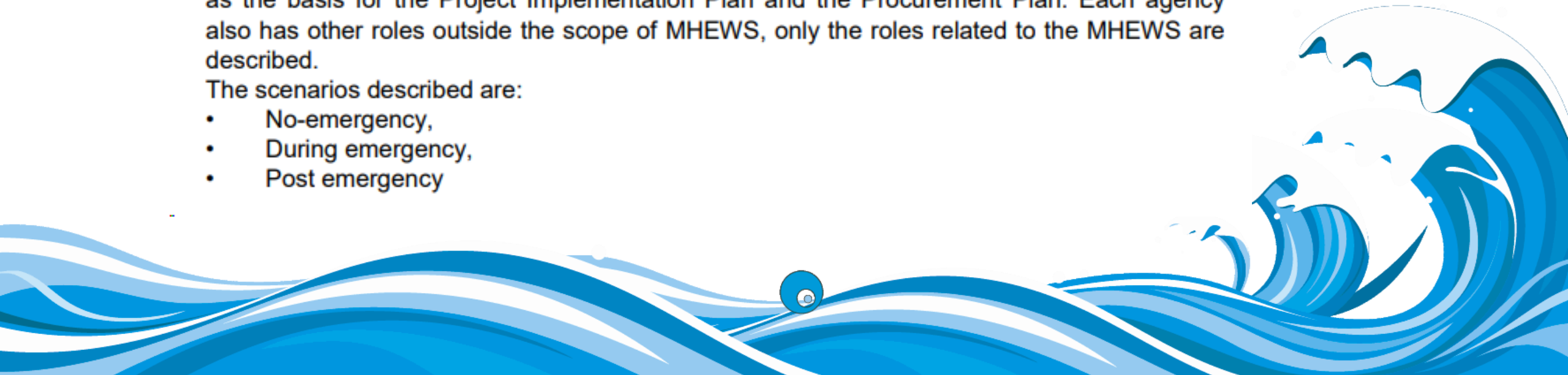
Concept of Operations: Cabinet Approval

Operational Roles of the MHEWS Agencies

The preliminary Concept of Operations (an operational strategy) describes for each of participating agencies, TMS, NRD, and NEMO, the role it has in the new designed MHEWS system for different scenarios, and according to current agency agreements. This will be used as the basis for the Project Implementation Plan and the Procurement Plan. Each agency also has other roles outside the scope of MHEWS, only the roles related to the MHEWS are described.

The scenarios described are:

- No-emergency,
- During emergency,
- Post emergency



MHEWS Concept of Operations: Cabinet Approval

No-emergency Scenario

This is the most common scenario, the periods when there is no emergency in sight.

TMS	NRD	NEMO
<p>On 24/7 schedule:</p> <ul style="list-style-type: none"> • Monitor data from seismic, volcanic, weather, and coastal stations, PTWC, USGS, ORSNET and RIMES • Run models to analyze and prepare predictions • Prepare meteorological and ocean forecasts and warnings (Rain, wind, temperature, sea & swell) • Transmit forecasts by SMS, web, radio, email, social media, VHF and HF radio • Quality Management and testing of communication channels • Provide back up to GSU on earthquake, volcano and hydrological monitoring • Develop and maintain forecast models • Research SOP thresholds/criteria for warnings including impact analysis and public scope for action in-collaboration with NEMO and 	<p>On normal schedule:</p> <ul style="list-style-type: none"> • Develop and maintain flood forecast models • Monitor data from seismic, volcanic during working hours • Develop and maintain Tsunami impact/forecast models • Develop flood hazards maps for Tsunami, Storm surge, Fluvial, and Pluvial flooding for MHEWS purposes • Make flood risk maps available to public, investors, planners, relief agencies. • Maintain Tonga seismic network, including real-time GNSS and telemetry to agreed standards • Provide back up for tsunami warnings and meteorological data to TMS • Quality Management and testing of communication channels. • Research SOP thresholds/criteria for warnings including impact 	<p>On normal schedule:</p> <ul style="list-style-type: none"> • Develop, test and maintain emergency management system including evacuation plans and operational support plans with updated hazard maps • Research SOP thresholds/criteria for warnings including impact analysis and public scope for action in-collaboration with NRD and TMS • Capacity development, education and awareness programs, technical assistance to increase the preparedness and response capacity at all levels (From national to village levels and Government to NGOs level). • Quality management and testing of communication channels • Back up of MET and GSU Data • Carry out user surveys on products and services (of NRD and TMS) in collaboration with NRD and TMS Monitor state of community readiness for each Natural Disaster • Conduct training of NEMO

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NRD	analysis and public scope for action in collaboration with NEMO and TMS	personnel
<ul style="list-style-type: none">• Maintain state-of-the-art knowledge of relevant meteorological developments• Carry out user surveys on products and services in collaboration with NRD and NEMO• Conduct training of meteorology personnel's• Continuous exercises to validate SOPs and Legal requirements• Carry out maintenance of systems and equipment• Maintain databases (including impact based)• Carry out awareness programs in collaboration with NRD and NEMO• Carry out research of meteorological and ocean aspects for improving the MHEWS	<ul style="list-style-type: none">• Maintain state-of-the-art knowledge of relevant hydrological, seismic, geologic and volcanic developments• Quality management and testing of communication channels• Carry out user surveys on products and services in collaboration with TMS and NEMO• Conduct training of NRD personnel's• Continuous exercises to validate SOPs and Legal requirements• Carry out maintenance of systems and equipment• Maintain databases (including impact based)• Carry out awareness programs in collaboration with TMS and NEMO• Carry out research of geo-hazards and ocean aspects for improving the MHEWS	<ul style="list-style-type: none">• Carry out maintenance of systems and equipment• Maintain databases (including impact based)

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Emergency Scenario

TMS	NRD	NEMO
Tropical Cyclone/ Severe Weather		
<p>On 24/7 schedule:</p> <ul style="list-style-type: none"> • Normal no-emergency operations are continued as described • Assess classify TC/SW stage and development • Issue NON-TC or TC severe weather alert or warning • notify and update NEMO on alerts 	<p>On normal schedule:</p> <ul style="list-style-type: none"> • Normal no-emergency operations are continued as described • Joint awareness program in collaboration with TMS and NEMO 	<p>On 24/7 schedule:</p> <ul style="list-style-type: none"> • 24/7 schedule is activated in the case of a TC event in coordination with TMS • In collaboration with TMS disseminate TCAs to agencies that form the National Disaster Management Committee • Mobilize specific instructions in the

TMS	NRD	NEMO
Local Tsunami		
<p>On 24/7 schedule:</p> <ul style="list-style-type: none"> • Monitor incoming data on earthquake or volcanic 	<p>On normal schedule:</p> <p>Normal no-emergency operations are continued</p>	<p>On activation:</p> <ul style="list-style-type: none"> • NEMO will follow up warnings with

TMS	NRD	NEMO
Distant Tsunami		
<p>On 24/7 schedule:</p> <ul style="list-style-type: none"> • Normal no-emergency operations are continued as described • if an earthquake or volcanic eruption occurs that can or has triggered a tsunami that may affect Tonga, the Pacific Tsunami Warning Centre (PTWC) will issue threat advisory notices and tsunami forecast products to TMS, the Tonga Tsunami Warning Focal Point (TWFP). The TMS uses these products together with running of tsunami models to issue tsunami warnings for Tonga in collaborations with NRD. 	<p>On activation:</p> <ul style="list-style-type: none"> • 24/7 schedule is activated in case of Tsunami in coordination with TMS • jointly with TMS carry out an assessment of threat for Tonga and determine whether to maintain a watch, cancel or issue warnings 	<p>On activation:</p> <ul style="list-style-type: none"> • 24/7 schedule is activated in case of Tsunami in coordination with TMS • Mobilize specific instructions in the event of a state of emergency • NEMO will follow up on



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TMS	NRD	NEMO
Coastal Flooding		
<p>On 24/7 schedule:</p> <ul style="list-style-type: none"> • Monitor meteorological and ocean conditions and issue warnings as required • Maintain/Develop SOPs for coastal flooding in collaboration with NRD and NEMO • Advice evacuation in accordance with procedures <p>On normal schedule:</p> <ul style="list-style-type: none"> • Normal no-emergency operations are continued as described (only when possible) 	<p>On Normal Schedule</p> <ul style="list-style-type: none"> • carry out an assessment of threat (including modelling) for Tonga on coastal inundation in collaboration with TMS and NEMO • Provide risk and hazardmaps and verifications of warning thresholds in collaboration with TMS and NEMO (and monitoring/reviewing thresholds) • Carry out surveys (including topographic mapping, bathymetric, extend of storm surges and run ups) and share reports in collaboration with TMS and NEMO 	<p>On Normal Schedule :</p> <ul style="list-style-type: none"> • Coordinate evacuation and logistics to evacuation centers. • Awareness programs in collaboration with NRD and TMS. <p>On normal schedule: Normal no-emergency operations are continued as described (when possible)</p>

	NRD	NEMO
Volcanic eruption		
<p>On 24/7 schedule:</p> <ul style="list-style-type: none"> • Normal no-emergency operations are continued as described • In case of eruption reports from maritime or aviation are received by TMS these reports are forwarded to NRD immediately for verifications and VONA reports are prepared by TMS in collaboration with NRD and are send to VAAC Wellington. • if local tremors occur that can indicate a developing volcanic eruption in Tonga, TMS to report to NRD or vice versa. • Back up support and monitoring of volcano eruptions as required 	<p>On activation:</p> <ul style="list-style-type: none"> • 24/7 schedule is activated as required in case of eruption. • carry out an assessment of threat for Tonga and determine whether to maintain a watch, cancel or issue warnings (for example, public and mariners' warnings)provide risk and hazard parameters regarding local impacts to TMS and NEMO. • In case of eruption that has the potential to affect aviation these reports are forwarded to TMS immediately and VONA reports are prepared by TMS in collaboration with NRD and are send to VAAC Wellington. 	<p>On activation:</p> <ul style="list-style-type: none"> • 24/7 schedule is activated in case of eruption on advice from NRD. • Mobilize specific instructions in the event of a state of emergency • NEMO will follow up on warnings with appropriate public advisory messages on preparedness measures and any necessary evacuation response or otherwise. • Upon receipt of "Warning Cancellation Message" from NRD, 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

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TMS	NRD	NEMO
Flash Floods & Landslides		
<p>On 24/7 schedule:</p> <ul style="list-style-type: none"> • Monitor meteorological heavy rain events and thunderstorms and issue warnings as required • Maintain/Develop SOPs for Flash floods and landslides in collaboration with NRD and NEMO • Advise evacuation in accordance with procedures • Data and event sharing in collaboration with NRD and NEMO <p>On normal schedule:</p> <ul style="list-style-type: none"> • Normal no-emergency operations are continued as described (only when possible) 	<p>On Normal Schedule</p> <ul style="list-style-type: none"> • carry out an assessment of threat (including modelling) for Tonga on coastal inundation in collaboration with TMS and NEMO • Provide risk and hazard maps and verifications of warning thresholds in collaboration with TMS and NEMO (and monitoring/reviewing thresholds) • Carry out surveys (including topographic mapping, extend of landslides and flash floods) and share reports in collaboration with TMS and NEMO • Data and event sharing in collaboration with TMS and NEMO 	<p>On Normal Schedule:</p> <ul style="list-style-type: none"> • Coordinate evacuation and logistics to evacuation centers. • Awareness programs in collaboration with NRD and TMS. • Data and event sharing in collaboration with TMS and NEMO <p>On normal schedule: Normal no-emergency operation are continued as described (when possible)</p>

TMS	NRD	NEMO
Droughts		
<p>On 24/7 schedule: Meteorological Drought</p> <ul style="list-style-type: none"> • Monitor rainfall and issue drought alerts or warnings as required. • carry out an assessment of meteorological drought threat (including modelling) for Tonga • Maintain/Develop SOPs for meteorological Drought in collaboration with NRD and NEMO • Advise and prepare climate outlooks and products to key stakeholders and users. • Agro-MET group meetings and awareness in collaboration with NRD and NEMO 	<p>On Normal Schedule: Hydrological Drought</p> <ul style="list-style-type: none"> • carry out an assessment of threat (including modelling) for Tonga on hydrological droughts in collaboration with TMS and NEMO • Provide risk and hazard maps for hydrological droughts and verifications of warning thresholds in collaboration with TMS and NEMO (and monitoring/reviewing thresholds) • Carry out surveys (including catchment mapping, extend of hydrological drought and water levels) and share reports in collaboration with TMS and NEMO 	<p>On Normal Schedule:</p> <ul style="list-style-type: none"> • Awareness programs in collaboration with NRD and TMS. • Mobilize specific instructions in the event of a state of emergency (meteorological or hydrological) <p>On normal schedule: Normal no-emergency operations are continued as described (when possible)</p>

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Post-Emergency Scenario

TMS	NRD	NEMO
<p>On 24/7 and normal schedule:</p> <ul style="list-style-type: none"> • Normal no-emergency operations are continued as described 	<p>On normal schedule:</p> <ul style="list-style-type: none"> • Normal no-emergency operations are continued as described • On 24/7 as required 	<p>On normal schedule:</p> <p>Normal no-emergency operations are continued as described</p> <ul style="list-style-type: none"> • On 24/7 as required
<ul style="list-style-type: none"> • To provide scientific and disaster assessment reports on event(s) as required. • Assess the effectiveness and usefulness of MHEWS to detect, confirm, and respond to recent emergency from the stakeholder's perspective through interviews or questionnaires (timeliness, quality, actionable, simplicity, target groups reached, target groups take desired actions, etc.) • Assess the effectiveness and usefulness of MHEWS to detect, confirm, and respond to recent emergency from the agency's perspective (capacity, organizational issues, cooperation, communication) • Evaluate performance of individual system components qualitatively and quantitatively: sensors, transmissions, data quality, models, impact assessment, communication methods and communication content. • Provide recommendations and carry out practical measures to improve MHEWS performance, for example, amendment to SOPs or legislations. 		



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TMS	NRD	NEMO
Flash Floods & Landslides		
<p>On 24/7 schedule:</p> <ul style="list-style-type: none"> • Monitor meteorological heavy rain events and thunderstorms and issue warnings as required • Maintain/Develop SOPs for Flash floods and landslides in collaboration with NRD and NEMO • Advise evacuation in accordance with procedures • Data and event sharing in collaboration with NRD and NEMO <p>On normal schedule:</p> <ul style="list-style-type: none"> • Normal no-emergency operations are continued as described (only when possible) 	<p>On Normal Schedule</p> <ul style="list-style-type: none"> • carry out an assessment of threat (including modelling) for Tonga on coastal inundation in collaboration with TMS and NEMO • Provide risk and hazard maps and verifications of warning thresholds in collaboration with TMS and NEMO (and monitoring/reviewing thresholds) • Carry out surveys (including topographic mapping, extend of landslides and flash floods) and share reports in collaboration with TMS and NEMO • Data and event sharing in collaboration with TMS and NEMO 	<p>On Normal Schedule:</p> <ul style="list-style-type: none"> • Coordinate evacuation and logistics to evacuation centers. • Awareness programs in collaboration with NRD and TMS. • Data and event sharing in collaboration with TMS and NEMO <p>On normal schedule: Normal no-emergency operation are continued as described (when possible)</p>

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Droughts		
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TMS	NRD	NEMO
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Tongan Meteorological Service		Natural Resources Division
Lead Agency	Joint activities	Lead Agency
24/7 Operations (MHEWS lead)	MHEWS design & coordination Public Education (with NEMO)	Planning & Resilience (with NEMO)
Real-time natural hazard warnings (non-volcanic) (includes tsunami, tropical cyclone, marine warnings)	Non-real time event management Joint operations for volcanic events (NRD join <u>TMS</u> 24/7 team during active volcanism)	Support to TMS for geohazards, including event modelling. State Volcano Observatory
Flood services	Hydrological services	Ground water services, coastal inundation mapping
WMO, ICAO & IOC liaison	Quality management	Geohazard liaison
Warning communications	Meteorological, Seismological, Volcanic, Tide observation maintenance	GIS work
Agriculture, marine & fisheries, tourism, defence, aviation, climate, drought	Joint training events	Natural resources & seismic services
	<-- Flow of information -->	
	NEMO liaison	

Figure 6-2 - Collaborative MHEWS model with Tongan Meteorological Service and the National Resources Division during 2019. The model assumes a strong joint management structure of the activities in common, overseen by both parent Departments, and with NEMO as the lead stakeholder.





TSUNAMIS

COMPETENCY FRAMEWORK

Tier 1: FTWC Tsunami incident controller

This tier requires a comprehensive understanding of tsunami causes and impacts, expert interpretation of TSP products, and competent performance of all key national warning procedures.

Tier 2: FTWC Tsunami Incident Assistant

This tier requires a basic understanding of tsunami causes and impacts, simple interpretation of TSP products, and ability to perform some tasks of the national warning procedures.

Key events for TMS Competency Framework

The target key events/sources for the TMS tsunami competencies are :

1. Local Events
2. Regional Events
3. Ocean-Worldwide Events

**Tsunami Competency Framework
Pilot Project: TONGA**



Our WAVE Forward



National Tsunami Response Plan
Responding & in-compliance

Joint Agency SOPs

Alignment to other SOPs & Flow of Action

Developing Tsunami Competencies

Tier 1 & Tier 2 established and certification

TMS Tsunami SOP & MHEWS Concept of Ops

The successful completion of the reviewing and amendment of the existing TMS SOP

