

TONGA: EARLY WARNING SYSTEMS NEEDS ASSESSMENT



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ACRONYMS

ADB	Asian Development Bank
BOM	Bureau of Meteorology (Australian Government)
CCA	Climate Change Adaptation
COSPPac	Climate and Oceans Support Program in the Pacific
CREWS	Climate Risk Early Warning System
DFAT	Department of Foreign Affairs and Trade (Australian Government)
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
EWS	Early Warning Systems
IDA	International Development Association
GCF	Green Climate Fund
GFDRR	Global Facility for Disaster Reduction and Recovery
JICA	Japan International Cooperation Agency
JNAP	Joint National Action Plan on Climate Change Adaptation and Disaster Risk Management
MOF	Ministry of Finance (Tonga)
MLSNR	Ministry of Lands, Survey and Natural Resources
MEIDECC	Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications
MHEWS	Multi-hazard early warning system
NEMO	National Emergency Management Office (Tonga)
NGOs	Non-government Organisations
NMS	National Meteorological Services
NRD	Natural Resources Division (Tonga)
NZMFAT	New Zealand Department of Foreign Affairs and Trade
PAD	Project Appraisal Document
PCRAFI	Pacific Catastrophe Risk Assessment and Financing Initiative
PIC	Pacific Island Country
PIFS	Pacific Island Forum Secretariat
PMC	Pacific Meteorological Council
PREP	Pacific Resilience Program
PTWC	Pacific Tsunami Warning Center
RSMC	Regional Specialised Meteorological Centre
SOP	Standard Operating Procedure
SPC	The Pacific Community
SPREP	Secretariat for the Pacific Environment Programme
SRDP	Strategy for Climate and Disaster Resilient Development in the Pacific
TMS	Tonga Meteorological Service
TOR	Terms of Reference
TTL	Task Team Leader
UNDP	United Nations Development Programme
UNISDR	United Nations Strategy for Disaster Reduction
WB	World Bank
WMO	World Meteorological Organisation

1. Introduction

1.1. Purpose of this document

This document provides an overview of needs and gaps in regards to early warning and response capabilities in Tonga. It consolidates information gathered in: (i) August 2014 during an early warning system (EWS) needs assessment to inform the development of the World Bank's Pacific Resilience Program (PREP); and (ii) August 2016 from discussions with key stakeholders (government bodies and development partners) about EWS activities currently underway or recently completed. Using this information this document identifies the needs for future EWS activities which remain unfunded.

A number of activities supporting EWS have been undertaken in Tonga in recent years. Section 5.2 of this report provides a matrix of activities against the key areas of EWS known at the time of writing this report. Appendix 1 provides links to obtain further information about these activities listed by development partner.

By providing a clear outline of the current state of play for EWS in Tonga and identified outstanding needs it is hoped this document will support discussions about future investments in this sector. It is not intended to commit any development partner, organisation or entity to any specific future initiative.

1.2. Background

In 2014 the World Bank undertook needs assessments in Tonga, Samoa and Vanuatu to help inform the development of the PREP. The aim of these assessments was to identify gaps in the capacity of agencies responsible for early warning systems in these countries and other stakeholders in order to inform the development of the PREP. The 2014 Tonga Needs Assessment is located at Appendix 2.

The PREP was approved by the World Bank in June 2015 and officially launched in June 2016. Appendix 3 provides an overview of PREP in Tonga. Further information about the PREP in Tonga is available at:

<http://projects.worldbank.org/P154840/?lang=en&tab=overview>.

1.3. Needs assessment methodology

In 2014 research was conducted using a wide variety of sources. The Reference List at Appendix 4 highlights some of the key documents consulted. Consultations with key stakeholders were held in person and via telephone and email to discuss gaps in the EWS capacity within Tonga. The PREP was then designed in consultation with the Government of Tonga and approved in 2015. With the project now 12 months underway it was decided it would be a good opportunity to assess outstanding EWS needs in order to help inform future investments. In August 2016 consultations with key stakeholders were undertaken to discuss work currently underway, planned or recently completed and outstanding gaps. This document is the consolidation of the information gathered in 2014 and 2016. A list of stakeholders consulted in 2016 is at Appendix 5.

2. Defining EWS, MHEWS and Impact-Based Forecasting

2.1. EWS

EWS can be defined as the combination of hazard detection, analysis, warning transmission, and community preparedness that enables individuals and communities to take preventative action to avoid damage or loss in advance of a hazard occurring. Hazards may include cyclones, tsunamis, earthquakes, floods, drought, volcanic eruptions, storm surge or severe weather events.

Literature on this topic highlights that the effectiveness of an EWS system relies on the EWS having a sound scientific and technical basis and a strong focus on the people exposed to risk.

The World Meteorological Organisation (WMO) sets out that in order to be effective, an EWS should integrate the following four key elements:

- 1) Hazard detection, monitoring and forecasting
- 2) Hazard analysis - analysing risks and incorporation of risk information into emergency planning and warnings
- 3) Dissemination of timely and authoritative warnings
- 4) Community Planning and Preparedness including well-considered emergency response plans and training on hazard/risk/emergency preparedness awareness integrated into various formal and informal education programs, with regular drills to ensure operational readiness.

In the absence of an adequate response the impacts of hazards result in disasters that affect a country's economic, human, and physical environment and impact their long-term development. The effectiveness of early warning systems designed to reduce exposure to hazards depends on people's capacity to understand and respond. This is a high priority in Pacific Island Countries (PICs) where early action is essential to save lives and to protect livelihoods and property.

2.2. Multi-Hazard Early Warning Systems and Impact-Based Forecasting

The adoption of the *Hyogo Framework for Action 2005-2015* and its successor, the *Sendai Framework for Disaster Risk Reduction 2015-2030* have led to a paradigm shift in disaster risk management from emergency response to a comprehensive approach which also includes preparedness and preventive strategies to reduce risk.

Multiple threats require an integrated response which has led to the development of so-called Multi Hazard Early Warning Systems (MHEWS).¹ Multi-agency coordination is critical to the successful implementation of a MHEWS because of the need for data sharing and a multiphase response involving many different stakeholders from the government and non-governmental agencies. This requires effective standard operating procedures (SOPs), frequent training and trials and feedback from these exercises used to improve the operational system. Critical to the development of impact-based forecasts is access to vulnerability data, which should be routinely updated.

¹ Although there is no commonly accepted approach to achieve a MHEWS, the WMO and GFDRR have favoured an approach developed by the Shanghai Meteorological Service and now adopted by the City of Shanghai, China and WMO as global good practice.

The development of impact-based forecast and warning systems should be based on the latest WMO guidelines.² These guidelines emphasis the importance of impact-based forecasting, that is, emphasising the impact of the weather, rather than simply conveying technical information about the weather itself. Translating technical warning information into impacts is recognised as a high priority to ensure that people take early action to minimise their exposure to extreme events both in regards to personal safety as well as from an economic perspective (eg. impacts on agricultural outputs, lost livelihoods and damaged or destroyed infrastructure).

Impact-based forecast and warning services rely on a comprehensive understanding of vulnerability and exposure because these forecasts are risk-based. That is, they use probabilistic forecasting techniques which look at the likelihood of a particular hazard causing an impact. Understanding this depends on data sharing and cooperation among multiple government agencies and civil society. It is important to ensure, therefore, that institutional capacity is increased, monitoring and forecasting systems are strengthened, and service delivery to the public and economic sectors is enhanced.

² *WMO Guidelines on Multi-hazard Impact-based forecast and warning services* (2015).

3. EWS in Tonga

3.1. Overview of Tonga’s hazard exposure

The Kingdom of Tonga consists of 172 islands with a total population of 103,252 people who inhabit 36 of these islands. Almost two-thirds of the population living on Tongatapu, home to the country’s capital Nuku’alofa. The country lies in the South Pacific and stretches over a distance of about 800 kilometers from north to south, covering a total land area of 748 square kilometers with an Exclusive Economic Zone (EEZ) of about 700,000 square kilometers.

Tonga is exposed to a range of natural hazards and is frequently impacted by severe weather, including tropical cyclones, which cause extensive damage due to winds, rain and storm surges. Tonga is also highly vulnerable to tsunamis and earthquakes because of its proximity to an active subduction zone. It is ranked second in the world (behind Vanuatu) as most disaster-prone in the world, according to the 2016 World Risk Index.³

In Tonga, the impact of natural disasters is equivalent to an annualised loss of 4.3 percent. In January 2014, Tropical Cyclone Ian (TCI) struck the country, recorded as the most powerful storm to ever hit the country. TCI affected some 5,500 people - almost 70 percent of the Ha’apai island group inhabitants - and caused damages and losses of \$50 million or 11 percent of Tonga’s GDP. The housing sector was particularly affected, with nearly a thousand houses and public buildings - or about 75 percent of Ha’apai’s housing stock - destroyed or severely damaged.

Catastrophic risk modeling indicates that Tonga is expected to incur, on average, US\$15.5 million per year in losses due to earthquakes and tropical cyclones. In the next 50 years, Tonga has a 50 percent chance of experiencing a loss exceeding US\$175 million and casualties higher than 440 people, and a 10 percent chance of experiencing a loss exceeding US\$430 million and casualties higher than 1,700 people.⁴ These estimates do not take climate change into account, which contributes to key risks to loss of livelihoods, coastal settlements, infrastructure, ecosystem services and economic stability.⁵ These risks are associated with current and future climate-related drivers, including sea-level rise, tropical and extra-tropical cyclones, increasing air and sea surface temperatures, and changing rainfall patterns. Table 1 below illustrates the risk profile for Tonga in terms of annual average losses from catastrophic events as modelled by the Pacific Catastrophe Risk Assessment and Financing Initiative (PCRAFI) in 2011.

Table 1: Risk Profile from Catastrophic Events in Tonga

	Annual Average Losses from Cyclones	Annual Average Losses from Earthquakes and Tsunami	Total
Direct Losses	USD 9.5m	USD 6.0m	USD 15.5m
Emergency Losses	USD 2.2m	USD 0.0m	USD 2.2m
Casualties	10 people	24 people	34 people

Source: PCRAFI Tonga (2011).

³ This index measures every country’s exposure and susceptibility to natural disasters, together with their coping and adaptive capacities using “globally available data.” It is available at <http://weltrisikobericht.de/wp-content/uploads/2016/08/WorldRiskReport2016.pdf>

⁴ PCRAFI Country Risk Profiles, World Bank, September 2011.

⁵ Fifth Assessment Report of the IPCC - Summary for Policy Makers, IPCC, 2014.

3.2. EWS governance arrangements in Tonga

The *Emergency Management Act 2007*, *National Emergency Management Plan (2009)*, and the *Government's Joint National Action Plan on Climate Change and Disaster Risk Management (2010-2015)* together provide a framework for emergency management within the Kingdom.

The Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Climate Change and Communications in Tonga (MEIDECC) has an overarching focus on climate resilience and disaster risk management and houses key institutions that are responsible for providing early warnings and response to meteorological, hydrological and geophysical hazards. It also works closely with the Ministry of Lands, Survey and Natural Resources (MLSNR).

The Tonga Meteorological Service (TMS), National Emergency Management Office (NEMO) and Natural Resources Division (NRD) form the core elements of Tonga's natural hazards forecast, warning and response system and are discussed in more detail below.

3.2.1 Tonga Meteorological Service (TMS)

The TMS, housed in MEIDECC, provides weather services, climate services, and is the national authority for issuing meteorological and geophysical hazard warnings. Although relatively small, the TMS has qualified staff (Class 1 Meteorologists), operating 24 hours by 7 days (24/7), to provide a full range of weather forecasts and warnings, TMS is also responsible for providing warnings of tsunamis based on data provided by Natural Resources Division (NRD). Staffing levels prevent TMS from supporting aviation meteorological services, which are provided by the Fiji Meteorological Service.

TMS maintains meteorological staff at 5 synoptic stations (a sixth station is in the process of being installed) covering the territory of the Kingdom of Tonga. This is critical for communication of warnings to the public in remote locations.

3.2.2 National Emergency Management Office (NEMO)

NEMO, housed in MEIDECC, is established under the *Emergency Management Act 2007*, and is responsible for managing emergency situations. NEMO currently has approximately 10 staff based in Nuku'alofa. NEMO does not have offices or staff in the outer islands and therefore relies heavily on the Governor's Office in Vava'u and Ha'apai and the Government Representatives Office in the two Niua's and 'Eua for their support. Operation Centers are activated from these offices when there is a declaration of emergency for outer islands but they are not properly equipped to deal with emergencies.

3.2.3 Natural Resources Division (NRD)

NRD, housed in MLSNR, is responsible for earthquake monitoring, mapping, vulnerability assessments and other related activities, along with a shared responsibility for hydrological and geophysical warning services with TMS.

3.3. Regional EWS Support

The *Framework for Resilient Development in the Pacific: An Integrated Approach to Address Climate Change and Disaster Risk Management 2017-2030* provides guidance and support for the implementation of climate change and disaster resilient development in the Pacific Island region and a framework for the Pacific Resilience Partnership. The three regional organisations below have mandates to assist with EWS across PICs:

- **Pacific Community (SPC)** - provides technical and policy advice and support to strengthen disaster risk management practices in PICs.
- **Pacific Islands Forum Secretariat (PIFS)** – provides a policy/advocacy role in relation to promoting resilience and investments in resilience, including EWS.
- **Secretariat of the Pacific Regional Environment Programme (SPREP)** - provides assistance to Pacific countries and territories to protect and improve their environment and to respond to key challenges such as climate change and the management of waste.

In general, PICs work closely with each other and with regional organisations to share information, warnings and operational guidance in relation to EWS. The Fiji Meteorological Service, Fiji Tropical Cyclone Warning Centre, the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service and Pacific Tsunami Warning Centre (PTWC) in Hawaii and the WMO Regional Specialised Meteorological Centers (RSMCs) in Nadi and Wellington provide significant support.

The Pacific region includes some of the most advanced National Meteorological Services (NMSs) (Australia; China; Hong Kong SAR, China; Japan; the Republic of Korea; and New Zealand). Advanced NMSs in France, India, the Russian Federation, the United Kingdom, and the United States also provide support to NMSs in East Asia and the Pacific bilaterally or through the WMO.

A coordinated approach and the sharing of knowledge, data, resources and lessons learnt is critical to building overall capacity to manage EWS across the region. Coordination of activities in relation to EWS has been supported through initiatives such as the Pacific Platform for Disaster Risk Management, an annual conference jointly organised by the United Nations Office for Disaster Risk Reduction (UNISDR) and SPC with support from PIFS, SPREP and other international and national partners. [Appendix 1](#) provides a summary of key EWS activities in Tonga including regional projects which aim to benefit Tonga.

The “Stocktake of Early Warning Systems in the Pacific” published by the Australian Government (DFAT) in July 2016 highlights that overall tropical cyclone and health EWS across the Pacific are more advanced than EWS for flood, volcano or tsunami. The Stocktake also found that the most significant gap across the region is the lack of flood hazard detection infrastructure capacity as well as particular gaps in hazard detection infrastructure for volcano hazards in Samoa, Tonga and Solomon Islands.⁶

⁶ This report fulfilled a commitment made at the Pacific Island Forum Foreign Ministers Meeting held on 10 July 2015 and is available upon request from Paula Claudianos (paula.claudianos@dfat.gov.au).

4. Tonga EWS Needs Assessments 2014 and 2016

4.1. Key themes based on 2014 EWS consultations in Tonga

In 2014 the World Bank undertook a needs assessment of EWS in Tonga to help inform the development of the PREP. This needs assessment identified four key needs and actions to support these as outlined in Table 2 below. These needs were also reflected in discussions with the governments of Samoa and Vanuatu, where similar needs assessments were undertaken. The parallels between countries drove the development of PREP as a regional program. More information about PREP is available at: <http://projects.worldbank.org/P147839?lang=en>.

Table 2: Identified needs and suggested actions to strengthen EWS

Identified needs	Actions to strengthen EWS
1. Institutional and regulatory strengthening, capacity building and implementation support	<ul style="list-style-type: none"> a) Institutional strengthening and development of a legal and regulatory framework b) Capacity Building and Training c) Systems design and integration, component management and monitoring
2. Modernisation of the Observation Infrastructure, Data Management Systems, Forecasting and Warning Systems and supporting infrastructure	<ul style="list-style-type: none"> a) Modernisation of the Observation Infrastructure to support improved forecasting and warning capability b) Upgrade of data management, communication, and IT systems c) Reconstruction and refurbishment of facilities
3. Enhancement of the MHEWS Service Delivery Systems and impact-based forecasting	<ul style="list-style-type: none"> a) Enhancement of MHEWS Service Delivery Systems b) Enhancement of impact-based forecasting
4. Strengthen community preparedness	<ul style="list-style-type: none"> a) Strengthen community planning b) Capacity building for community early warning preparedness (eg. drills to test for each community evacuation plans, ensure evacuation plans are congruent with warnings issued from warning agencies, training for community based organisations and national agencies working with communities to apply Community Disaster and Climate Resilience Program’s methodology) c) Strengthen community infrastructure (eg. evacuation centres, emergency stockpiles)

4.2. Current state of play and outstanding EWS gaps in Tonga

Since the initial needs assessment consultations in 2014 that informed the development of PREP a number of other projects have also contributed to improved EWS in Tonga. Whilst PREP aims to support, at large, all the suggested actions outlined in section 5.1 above, consultations in 2016 have revealed that there are specific gaps not covered by PREP or other key development partner projects which are important to understand in order to better understand where future support should be targeted.

Using the suggested actions to strengthen EWS derived from 2014 as a framework, the tables below outline key projects recently completed (within 12 months), currently underway and planned which have helped address these suggested actions. Outstanding gaps based on 2016 consultations are highlighted within each of these. It is hoped that by breaking down activities and gaps into quite specific areas it will make it easier to understand these gaps and also highlight which development partners are operating in these specific areas.

4.2.1 Institutional and regulatory strengthening, capacity building and implementation support

Consultations in 2014 highlighted that ongoing support for training was required to maintain currency of staff, particularly with the introduction of new techniques to improve forecasts and warnings. Since 2014, a range of projects as outlined in Table 4 below have looked at such support via twinning arrangements with the institutions leading the development of these skills.

Despite these efforts, the following key outstanding gaps emerged in the 2016 consultations as outlined in Tables 3, 4 and 5 below:

- a) Strengthening of strategic and management planning (including budget) of relevant staff in MEIDECC, NEMO and TMS to ensure key staff are able to assist with detailed planning at the program level.
- b) Recruitment of more meteorologists to TMS (currently only 3) ensuring they have necessary qualifications and ensuring there are sufficient staff trained in communicating impact-based forecasts and warnings.
- c) Capacity building for new maritime radio station staff.
- d) Capacity building training for staff providing tsunami warnings.
- e) Building capacity to ensure relevant agencies can be certified as required (eg. TMS services for Aviation are required by law (Civil Aviation Act) to be certified under NZCAA Rules Part 174).
- f) Maintenance training and maintenance equipment - TMS needs both a workshop shed/space equipped with the necessary tools and instruments to carry out calibration and maintenance of meteorological instruments and workstations as well as specialised training of 2 technicians.

Table 3: Current activities to support institutional strengthening and development of legal and regulatory framework

Development partner	Project name	Project description	Timeframe
World Bank	Pacific Resilience Program (PREP)	Development of a legal and regulatory framework for MHEWS including standard operating procedures; Legal services to review the current institutional and regulatory framework for exchange of data and information and suggest improvement for better functioning; and Governance Specialist to ensure the consistency of the TOR for the agencies and the coordination among them.	FY16-FY20
ADB	Climate Resilience Sector Project	Integration of climate resilience in legal framework.	FY13-FY19

Development partner	Project name	Project description	Timeframe
	(CRSP)		
NZMFAT	Pacific DRM Support	NZ Ministry of Civil Defence and Emergency Management (MCDEM) will undertake a review of Tonga's legislation for disaster and Tonga's National Disaster Management Plan to ensure it is suitable and enables effective disaster management practice. MCDEM will support NEMO to develop new, or update existing, national response SOPs.	FY14-FY19
NEEDS / GAPS	Strengthening of strategic and management planning (including budget) of relevant staff in MEIDECC, NEMO and TMS to ensure key staff are able to assist with detailed planning at the program level.		

Table 4: Current activities to support capacity building and training

Development partner	Project name	Project description	Timeframe
World Bank	Pacific Resilience Program (PREP)	Twinning Operational Support from WMO and training of relevant Tongan staff through WMO regional training centers, PTWC, SPREP, SPC, etc.	FY16-FY20
ADB	Climate Resilience Sector Project (CRSP)	Short term professional training / work placements on CCA DRR for 20 relevant government staff. Up to 20 scholarships for Tongan citizens to undertake academic degrees on CCA and DRM subjects at USP.	FY13-FY19
DFAT	Climate and Oceans Support Program for the Pacific (COSPPac)	COSPPac's implementing partners, the Australian Bureau of Meteorology, Geoscience Australia and the Secretariat of the Pacific Community have provided products, training, and services to assist government agencies to apply climate and ocean research to national planning and decision-making.	FY12-FY16
JICA	Project for Nationwide Early Warning Dissemination and Strengthening Disaster Communications	Training and skill transfer for disaster communications operations.	FY17-FY19
NZMFAT	Pacific DRM Support	The MCDEM project aims to support NEMO staff obtain identified training or development opportunities that will increase their capability and capacity (preceded by a development needs analysis).	FY14-FY19
NEEDS / GAPS	(a) Recruitment of more meteorologists to TMS ensuring they have necessary qualifications and ensuring there are sufficient staff trained in communicating impact-based forecasts and warnings.		

	<p>(b) Capacity building for new maritime radio station staff.</p> <p>(c) Capacity building training for staff providing tsunami warnings.</p> <p>(d) Building capacity to ensure relevant agencies can be certified as required (eg. TMS services for Aviation are required by law (Civil Aviation Act) to be certified under NZCAA Rules Part 174).</p> <p>(e) Maintenance training and maintenance equipment - TMS needs both a workshop shed/space equipped with the necessary tools and instruments to carry out calibration and maintenance of meteorological instruments and workstations as well as specialised training of 2 technicians.</p>
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Table 5: Current activities to support systems management (systems design and integration, component management and monitoring)

Development partner	Project name	Project description	Timeframe
World Bank	Pacific Resilience Program (PREP)	The project will hire a Systems Integrator Consultant to ensure the integration of various project components and activities to strengthen the capacities of the respective agencies responsible for meteorological, hydrological, geophysical monitoring, forecasts and warning services and disaster management. A disaster management survey and information officer will also be hired to provide 6 monthly reports on the effectiveness of EWS systems.	FY16-FY20
NEEDS / GAPS	No major gaps presently known.		

4.2.2 Modernisation of the Observation Infrastructure, Data Management Systems, Forecasting and Warning Systems and supporting infrastructure

Consultations in 2014 highlighted inadequate communication between TMS headquarters and TMS stations, NRD, NEMO, emergency services and the public, especially on remote islands. Efforts to improve this are being facilitated by PREP and the JICA Project for Nationwide Early Warning Dissemination and Strengthening Disaster Communications. Under PREP, a new purpose-built facility is being constructed for TMS/NEMO which will also facilitate greater communications. Consultations in 2016 have highlighted that an outstanding gap remains ensuring that there is adequate infrastructure to ensure warnings reach remote communities on outer islands.

Feedback from 2014 suggested that arrangements for data and information sharing would benefit from more formal regulation and so PREP is assisting to provide a regulatory framework for warning and response including data sharing, the issuance of warnings and the expected response from local officials and communities.

Despite significant efforts in this space, as outlined in Tables 6, 7 and 8 below, consultations in 2016 have highlighted the following outstanding gaps:

- a) Flood forecasting capacity is extremely limited as highlighted with the June 2016 flooding of Nuku'alofa (worst flood on record) and in some of the Ha'apai Islands in May 2016. Capacity in catchment monitoring and setting up of a flood forecasting unit within TMS is required.
- b) Whilst the forecasting of tropical cyclones is ok, the forecasting of the rain associated with tropical cyclones requires improvement. To improve considerably the accuracy of forecasts of these events, it is recommended that 2 Radars are installed one each in Tongatapu and Vava'u to cover the whole Tonga group. The acquisition of radars needs to be complemented by the acquisition of nowcasting systems. Technicians will need to also be trained to manage this new technology.
- c) Tsunami warning system - whilst the planned Alert System (sirens and communication) under the Japan Grant Aid for warning communities is an excellent initiative, still, there is no reliable way by which the warning center can detect that a local tsunami has been generated. TMS have recommended that dart buoys for detecting tsunami are installed strategically along the Tonga Trench.

Table 6: Current activities to support modernisation of observation infrastructure to support improved forecasting and warning capability

Development partner	Project name	Project description	Timeframe
World Bank	Pacific Resilience Program (PREP)	Upgrade of observation infrastructure, upgrade of the seismic network including GPS for volcano and earthquake monitoring, upgrade of marine and community communication infrastructure (HF and VHF) for TMS, NEMO and NRD.	FY16-FY20
ADB	Climate Resilience Sector Project (CRSP)	Establishment of national hydro-meteorological and coastal monitoring and data dissemination systems to improve early warning for cyclones, storm surges, drought and tsunamis through (a) designing and installing hydro-meteorological and coastal monitoring and data dissemination systems; and (b) training staff in national emergency management office (NEMO), natural resources division and meteorology division to operate these systems and interpret data to enable them to provide information and shape national policies on natural resources (especially freshwater, agriculture and coastal zones).	FY13-FY19
DFAT	Support to TMS	Provision of equipment (eg satellite phone, standby generator etc) to enhance communication, build capacity of staff and also the construction of a weather station in 'Eua.	FY17
JICA	Project for Nationwide Early Warning Dissemination and Strengthening Disaster Communications	<ul style="list-style-type: none"> • V/UHF command radio system • VHF radio link for outdoor sound alert system • Early warning sound alert system across all islands including 14 sirens, 72 loudspeakers, 1000 remote activated radio terminals and 5 remote control systems • Improvement of Tonga Broadcasting Commission (TBC) broadcasting equipment at Popua site • Improvement of TBC broadcasting equipment at 	FY17-FY19

Development partner	Project name	Project description	Timeframe
		<p>Fasimoeafi site</p> <ul style="list-style-type: none"> • Improvement of AM/FM transmission and reception in the Niua islands of Niuatoputapu and Niuafou'ou 	
NZMFAT	Pacific DRM Support	<p>Provision of satellite phones, laptops, printers and generators for National Emergency Management Office (NEMO) outer island operation centres at 'Eua, Ha'apai, Vava'u, Niuafou'ou and Niuatoputapu.</p> <p>In addition the MCDEM project aims to ensure Tonga's national EOC facility (to be built by PREP) is appropriately resourced with facilities and equipment, and technical advice for outfitting an EOC to enhance capability.</p> <p>MCDEM will also provide support for the Early Warning System (being built by Japan) with a review of the Tsunami SOP, technical advice to train NEMO staff and villages on the new system, and implementation and maintenance support.</p>	FY16-FY17
WMO	(Proposed) Strengthening Hydro-Meteorological and Early Warning Services in the Pacific Project	<p>Strengthen the RSMC in Fiji Meteorological Service ability to support PICs, including Tonga, who use RSMC as a special advisor. Upgrade the forecasting capabilities of Tonga to access high resolution regional NWP guidance provided by FMS/RSMC and to access high performance computing numerical weather prediction models and support tools from other developed centres and RSMCs. These improvements would be linked to improving flood forecasting.</p>	FY18-FY22
NEEDS / GAPS	<p>(a) Flood forecasting capacity is extremely limited as highlighted with the June 2016 flooding of Nuku'alofa (worst flood on record) and in some of the Ha'apai Islands in May 2016. Capacity in catchment monitoring and setting up of a flood forecasting unit either within the TMS is required.</p> <p>(b) Whilst the forecasting of tropical cyclones is ok, the forecasting of the rain associated with tropical cyclones requires improvement. To improve considerably the accuracy of forecasts of these events, it is recommended that 2 Radars are installed one each in Tongatapu and Vava'u to cover the whole Tonga group. The acquisition of radars needs to be complemented by the acquisition of nowcasting systems. Technicians will need to also be trained to manage this new technology.</p> <p>(c) Tsunami warning system - whilst the planned Alert System (sirens and communication) under the Japan Grant Aid for warning communities is an excellent initiative, still, there is no reliable way by which the warning center can detect that a local tsunami has been generated. TMS have recommended that dart buoys for detecting tsunami are installed strategically along the Tonga Trench.</p>		

Table 7: Current activities to support upgrading of data management, communication and IT systems

Development partner	Project name	Project description	Timeframe
World Bank	Pacific Resilience Program (PREP)	Upgrade of data management, communication and IT system for TMS, NEMO and NRD. This includes data management systems are fully integrated for all sources of data and a dedicated fiber optic communication link between all disaster response agencies.	FY16-FY20
NEEDS / GAPS	Adequate infrastructure to ensure warnings reach remote communities on outer islands.		

Table 8: Current activities to support reconstruction and refurbishment of facilities

Development partner	Project name	Project description	Timeframe
World Bank	Pacific Resilience Program (PREP)	Design and supervision for TMS; Building of new facility for TMS and NEMO headquarters in Tongatapu. Design and supervision for Rehabilitation and construction of Emergency Operations Centers (EOC) in outer islands of Ha'apai and Vava'u.	FY16-FY20
JICA	(Proposed) Project for Nationwide Early Warning Dissemination and Strengthening Disaster Communications	<ul style="list-style-type: none"> • Improvement of Tonga Broadcasting Commission (TBC) facilities at Popua site • Improvement of TBC broadcasting equipment and facilities at Fasimoeafi site. 	FY17-FY19
NEEDS / GAPS	No major gaps presently known.		

4.2.3 Enhancement of the MHEWS Service Delivery Systems and impact-based forecasting

Multi-agency coordination is critical to the successful implementation of a MHEWS because of the need for data sharing and a multiphase response involving many different stakeholders from the government and non-governmental agencies. This requires effective SOPs which enable effective coordination among agencies across the components of early warning systems, at national and local levels (horizontally and vertically)

Consultations in 2014 highlighted a need for an enhanced MHEWS and investment in protocols and visualisation tools and capacity development in terms of translating forecasts and warnings into impacts. This is being supported by PREP and the WMO as outlined in Tables 9 and 10 below, however, consultations have revealed that there is a need for an assessment on whether there is

sufficient information on the vulnerability of all communities to key hazards. Consultations in 2016 have highlighted that there is still more effort needed in ensuring that warnings reach remote communities on outer islands. This is a common issue in regards to MHEWS service delivery across the remote communities in Pacific island countries.

Table 9: Current activities to support enhancement of MHEWS Service Delivery Systems

Development partner	Project name	Project description	Timeframe
World Bank	Pacific Resilience Program (PREP)	Enhancement of MHEWS systems through procurements of computers, software and visualisation tools for computation of impact forecasts and warnings. Improvement of service delivery to communities through the upgrade of the Tonga Meteorological Service, NEMO and NRD (Geohazards) websites. Expansion of the MHEWS services to sectors.	FY16-FY20
WMO	(Proposed) Strengthening Hydro-Meteorological and Early Warning Services in the Pacific Project	Strengthen the RSMC in Fiji Meteorological Service ability to support PICs, including Tonga, who use RSMC as a special advisor. Includes strengthening the abilities of the relevant staff in Tonga to use the information provided by the RSMC to interpret and disseminate impact-based forecast and warning products.	FY18-FY22
NEEDS / GAPS	Ensuring warnings reach remote communities on outer islands.		

Table 10: Current activities to support enhancement of impact forecasting

Development partner	Project name	Project description	Timeframe
World Bank	Pacific Resilience Program (PREP)	Development, improvement and operationalisation of production of basic and specialised information products. This will include using InaSAFE, a free software that produces realistic natural hazard impact scenarios for better planning, preparedness and response activities.	FY16-FY20
WMO	(Proposed) Strengthening Hydro-Meteorological and Early Warning Services in the Pacific Project	Strengthen the RSMC in Fiji Meteorological Service ability to support PICs, including Tonga, who use RSMC as a special advisor. Includes strengthening the abilities of the relevant staff in Tonga to use the information provided by the RSMC to interpret and disseminate impact-based forecast and warning products and translate weather forecasts and warnings into actionable information to support decision makers.	FY18-FY22
NEEDS / GAPS	An assessment on whether there is sufficient information on the vulnerability of all communities to key hazards is needed.		

4.2.4 Strengthen community preparedness

Public education of hazard risks remains limited and feedback in both 2014 and 2016 highlights that the population does not fully understand the information communicated to them often resulting in an inadequate response. Ongoing and frequently repeated education campaigns and drills remain necessary and are supported through a number of projects which aim to improve community preparedness as outlined in Tables 11, 12 and 13 below. PREP will support the development of a Television Weather Presentation, however, there needs to be an equivalent presentation via radio as many outer island populations do not have television.

Consultations in 2014 highlighted that the structural integrity and capacity of identified evacuation centres will need to be undertaken and recommendations for improvement provided to Government. This is not specifically being looked at under PREP. DFAT have just constructed an evacuation centre on 'Eua island which is of international standard, however, 2016 consultations have revealed that an outstanding gap remains evacuation centres / cyclone proof community buildings to international standards across Tongatapu and Ha'apai.

Table 11: Current activities to strengthen community planning

Development partner	Project name	Project description	Timeframe
World Bank	Pacific Resilience Program (PREP)	Training of community based organisations and national agencies to develop and implement village disaster preparedness and response plans.	FY16-FY20
ADB	Climate Resilience Sector Project (CRSP)	The project will (a) standardise the methodology to be used in Tonga for CCA and DRR community based plans as well as procedures and institutional set-up; (b) disseminate data through a searchable data base on CCA and DRM community based plans and on integrated water resource management plans; (c) strengthen MEIDECC's capacity to coordinate, monitor and evaluate the activities implemented by communities.	FY13-FY19
DFAT	Pacific Risk Resilience Program (PRRP)	The project will help PICs mainstream the risks they face from climate change and disasters into development planning and processes. The major objective is to support a strong enabling environment for risk governance to empower communities to identify risks and needs, and formulate and implement sustainable responses.	FY12-FY18
USA	Tonga Community Disaster Risk Management Project (TCDRM) Phase 2	This project involved the Tonga National Council of Churches (TNCC), supported by the NGO Act for Peace, to work directly with 29 vulnerable communities across Tonga (17 in Vava'u, 8 in Ha'apai and 4 in Tongatapu) to develop Village Emergency Committees and Village Emergency Plans to increase their resilience to disasters. The TNCC also supported the National Emergency	FY16

		Management Office (NEMO) in collaboration with SPC/SOPAC1 to undertake national consultations to develop a draft Community-based Disaster Risk Management Framework.	
NEEDS / GAPS	No major gaps presently known.		

Table 12: Current activities to build capacity for community early warning preparedness (eg. drills, training)

Development partner	Project name	Project description	Timeframe
World Bank	Pacific Resilience Program (PREP)	Engagement of NGOs to conduct community training and awareness on access and understand MHEWS data / information and to use them for response/ preparedness. This includes operational training and drills with government stakeholders and communities including all islands (37-170 communities) for the new MHEWS services, developing and testing community evacuation plans and procedures in line with warning criteria and certification of communities as "hazard ready".	FY16-FY20
DFAT	Development assistance	Building community awareness and the community's capacity to respond to emergencies/disasters through training of volunteers and community leaders. Training/community awareness programs are also aimed at building the capacity of the Tonga Red Cross and public to deal with emergency situations. Trainings are planned throughout the year with some such as Emergency Response Team, Shelter training completed in September 2016.	FY17
NZMFAT	Tsunami Evacuation Sign review	The effectiveness of the tsunami evacuation signs on Tongatapu were assessed in late 2016 by NZ Defence, however, due to this information being included in a broader classified report NZMFAT have not been able to share this information. Two key components of the MCDEM project are: support for community response and local evacuation plans (to increase communities' understanding of how to respond and their preparedness); and second, support for national/community drills and exercises. This support to NEMO is to develop, run and evaluate national exercises such as PacWave; and to test national warning systems, plans, and stakeholder preparedness. (This may build on PREP activities in this area).	FY17

USA	Tonga Community Disaster Risk Management Project (TCDRM) Phase 2	This project involved the Tonga National Council of Churches (TNCC), supported by the NGO Act for Peace, to work directly with 29 vulnerable communities across Tonga (17 in Vava'u, 8 in Ha'apai and 4 in Tongatapu) to undertake simulation exercises as an opportunity to practice disaster plans in a controlled environment, helping authorities and aid agencies identify ways of improving preparedness and response systems before a disaster occurs.	FY16
NEEDS / GAPS	No major gaps presently known.		

Table 13: Current activities to strengthen community infrastructure (eg. evacuation centres, emergency stockpiles)

Development partner	Project name	Project description	Timeframe
World Bank	Pacific Resilience Program (PREP)	Stockpiling of emergency goods to enhance preparedness and response including procurements of emergency goods such as tents, tarpaulins, water containers, stretchers, portable toilets, cooking utensils, chainsaw, generators and de-water pumps.	FY16-FY20
DFAT	Development assistance	Stockpiling non-food items for use in emergency situations. DFAT work primarily through the Australian Red Cross on stockpiling non-food items, warehouses to store supplies for use in emergency situations for the Tonga Red Cross.	FY17
DFAT	Pacific Risk Resilience Program (PRRP)	Construction of international standard, cyclone-proof, multi-purpose community halls that double as evacuation centres on 'Eua island.	FY12-FY18
NZMFAT	Pacific DRM Support	Support is provided through Oxfam and Caritas to procure and stock emergency goods such as hygiene kits, blankets, buckets, non-food items, jerry cans etc.	FY14-FY19
NEEDS / GAPS	Evacuation centres/cyclone proof community buildings to international standards across Tongatapu and Ha'apai.		

5. Conclusion

The findings from the 2014 needs assessment process and follow up consultations in 2016 have provided an opportunity for development partners and the Government of Tonga to better understand the state of play of Tonga's EWS arrangements and activities.

The key gaps outlined in Chapter 4 are summarised here:

- (i) *Institutional and regulatory strengthening, capacity building and implementation support*
 - a) Strengthening of strategic and management planning (including budget) of relevant staff in MEIDECC, NEMO and TMS to ensure key staff are able to assist with detailed planning at the program level.
 - b) Recruitment of more meteorologists to TMS (currently only 3) ensuring they have necessary qualifications and ensuring there are sufficient staff trained in communicating impact-based forecasts and warnings.
 - c) Capacity building for new maritime radio station staff.
 - d) Capacity building training for staff providing tsunami warnings.
 - e) Building capacity to ensure relevant agencies can be certified as required (eg. TMS services for Aviation are required by law (Civil Aviation Act) to be certified under NZCAA Rules Part 174).
 - f) Maintenance training and maintenance equipment - TMS needs both a workshop shed/space equipped with the necessary tools and instruments to carry out calibration and maintenance of meteorological instruments and workstations as well as specialised training of 2 technicians.

- (ii) *Modernisation of the Observation Infrastructure, Data Management Systems, Forecasting and Warning Systems and supporting infrastructure*
 - a) Flood forecasting capacity is extremely limited as highlighted with the June 2016 flooding of Nuku'alofa (worst flood on record) and in some of the Ha'apai Islands in May 2016. Capacity in catchment monitoring and setting up of a flood forecasting unit either within the TMS is required.
 - b) Whilst the forecasting of tropical cyclones is ok, the forecasting of the rain associated with tropical cyclones requires improvement. To improve considerably the accuracy of forecasts of these events, it is recommended that 2 Radars are installed one each in Tongatapu and Vava'u to cover the whole Tonga group. The acquisition of radars needs to be complemented by the acquisition of nowcasting systems. Technicians will need to also be trained to manage this new technology.
 - c) Tsunami warning system - whilst the planned Alert System (sirens and communication) under the Japan Grant Aid for warning communities is an excellent initiative, still, there is no reliable way by which the warning center can detect that a local tsunami has been generated. TMS have recommended that dart buoys for detecting tsunami are installed strategically along the Tonga Trench.

- (iii) *Enhancement of the MHEWS Service Delivery Systems and impact-based forecasting*
 - a) An assessment on whether there is sufficient information on the vulnerability of all communities to key hazards is needed.
 - b) Ensuring warnings reach remote communities on outer islands.

(iv) *Strengthen community preparedness*

- a) Evacuation centres/ cyclone proof community buildings to international standards across Tongatapu and Ha'apai.

Capacity building came out as the most significant gap across all areas and TMS expressed considerable concern around the current small number of adequately trained staff. Ensuring that appropriate warnings reach remote communities on outer islands and ensuring these communities are provided with educational campaigns and drills to raise awareness of appropriate responses in a range of scenarios.

These outstanding needs may fluctuate as various projects close and new projects come online so it is important to recognise the importance of ongoing dialogue to ensure these needs are addressed appropriately. It is most important to talk with MEIDECC as the lead Government Ministry in this space.

It is evident that many development partners are paying greater attention to the mainstreaming of disaster and climate risk issues in their operations and are providing enhanced support for targeted climate change assessment (CCA) and disaster risk management (DRM) activities. This has resulted in a growing number of projects with components related to EWS and preparedness. In light of this, coordination across such efforts is increasingly important.

Consultations have revealed that the focus of EWS activities can be quite varied and tend to include a particular or combined focus on:

- a specific hazard (eg. tsunamis, cyclones, drought)
- support for a particular agency (eg. NEMO or TMS)
- improving communications (eg. radio/SMS/TV, between national agencies and/or RSMCs or greater communications for sparsely populated outer islands)
- community training from non-government organisations who have traditionally been the on the ground providers of post-disaster support funded by development partners (eg. DFAT provide response support namely through Tonga Red Cross and NZMFAT namely through Caritas Tonga).

It is clear that there is an ongoing need for development partners to ensure they work closely together in line with the expressed priorities of the Government of Tonga. In late 2016 NZMFAT developed a spreadsheet of DRR activities of key partners (including Australia, France, US, Japan, EU and World Bank) under the auspices of the Donor Statement of Disaster Risk Management. It has been recommended that this mechanism be used by NEMO to facilitate active coordination.

By providing a clear outline of identified outstanding needs this document is designed to support discussions about future investments in this sector.

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Appendix 1: Links to key EWS activities in Tonga by development partner

Below is a list of key EWS activities recently completed, underway or planned in Tonga, or regional projects which support Tonga, by development partner known at the time of writing this report.

Development partner	Location	Project name	Description	Timing	Link
ADB	Tonga	Climate Resilience Sector Project (CRSP)	The project aims to mainstream climate resilience into development planning and address country priorities focusing on the most vulnerable sectors and communities.	FY13-FY19	https://www.adb.org/projects/46351-002/main
DFAT	Tonga	Australian Civilian Corps volunteers to help bridge gap between emergency relief and long term recovery programs	Logistics specialist (consultant hired each year) sits with NEMO every cyclone season for 6 months (Sept-Mar).	Currently ongoing	http://dfat.gov.au/aid/topics/investment-priorities/building-resilience/acc/Pages/australian-civilian-corps.aspx
DFAT	Tonga	Support to TMS and disaster preparedness and response activities	Provision of equipment to TMS to enhance communication, build capacity of staff and also the construction of a weather station in 'Eua. Disaster preparedness and response activities are delivered through NGOs, namely the Tonga Red Cross.	FY17	http://dfat.gov.au/about-us/publications/Pages/aid-investment-plan-aip-tonga-2015-16-to-2018-19.aspx
DFAT	Regional (14 PICs including Tonga)	Climate and Oceans Support Program in the Pacific (COSPPac)	The project provided high quality technical and related support to Pacific Island NMSs so accurate, timely and essential weather, climate and ocean information is collected and analysed.	FY12-FY17	http://www.bom.gov.au/cosppac/comp/
DFAT	Regional	Disaster Preparedness funding announcement at PIF meeting 9 September 2016	Disaster preparedness activities based on Pacific National priorities. AUD75 million over 4 years.	FY17-FY21	https://www.pm.gov.au/media/2016-09-09/remarks-pacific-island-forum

Development partner	Location	Project name	Description	Timing	Link
DFAT	Regional (4 PICs including Tonga)	Pacific Risk Resilience Program	The project will help PICs mainstream the risks they face from climate change and disasters into development planning and processes. The major objective is to support a strong enabling environment for risk governance to empower communities to identify risks and needs, and formulate and implement sustainable responses.	FY14-FY18	http://dfat.gov.au/geo/pacific/development-assistance/Pages/resilience-pacific-regional.aspx
Finland	Regional (14 PICs including Tonga)	Finish-Pacific Reducing Vulnerability in the Pacific Island Communities Project (FINPAC)	The project aims to reduce vulnerability to climate change through strengthening NMS, improving meteorological systems and providing technical advice and outreach.	FY13-FY17	https://www.sprep.org/finpac/
JICA	Tonga	Project for Nationwide Early Warning Dissemination and Strengthening Disaster Communications (NEWS)	The project will provide an emergency radio system, an early warning sound alert system and improvement of AM Radio broadcasting infrastructure.	FY17-FY19	https://www.jica.go.jp/english/our_work/social_environmental/id/oceania/category_c.html
JICA	Regional	Strengthening Multi-Hazard Risk Assessment and Early Warning Systems with Applications of Space and Geographic Information Systems in Pacific Island Countries	The project aims to strengthen the capacity of multi-hazard assessment and early warning systems by using space technology and GIS applications, and to promote Pacific regional cooperation platforms on multi-hazard assessment and early warning systems.	FY16-FY18	http://www.geoinfo.ait.ac.th/index.php/projects/mapping/webgis/398-geo-drm-pacific

Development partner	Location	Project name	Description	Timing	Link
NZMFAT	Tonga	Pacific DRM Support	MFAT provides funding for the New Zealand Ministry of Civil Defence and Emergency Management (MCDEM) which works directly with Tonga's NEMO to support strengthened DRM management for response as well as risk reduction, readiness and recovery. MCDEM conducts disaster-response training in Tonga, assists in the drafting and review of emergency preparedness plans and helped establish the emergency operations centre in NEMO in 2014. In 2016 NZMFAT provided satellite phones, laptops, printers and generators for NEMO's outer island operation centres at 'Eua, Ha'apai, Vava'u, Niuafo'ou and Niuatoputapu. Disaster preparedness and response activities are delivered through NEMO and through some NGOs, namely Caritas Tonga.	Ongoing	https://www.mfat.govt.nz/en/aid-and-development/our-work-in-the-pacific/tonga/
Republic of Korea	Regional (14 PICs including Tonga)	Pacific Islands Climate Prediction Services Project (ROK PI-CLIPS)	The project aims to provide nationally-tailored seasonal climate prediction information and build the prediction capacity of PICs.	FY15-FY17	http://www.sprep.org/climate-change/climate-prediction-services-support-for-the-pacific
World Bank	Regional	Building Climate and Disaster Resilience in the Pacific	Technical assistance to strengthen PICs' capacity for improving early warning and preparedness, mainstreaming disaster and climate resilience in spatial planning and sector investments and improving disaster risk and climate financing mechanisms.	FY16-FY19	https://www.gfdr.org/acp-eu/programmatic-ta-building-climate-and-disaster-resilience-in-the-pacific

Development partner	Location	Project name	Description	Timing	Link
World Bank	Tonga	Pacific Resilience Program	A program of support for early warning, preparedness and response, resilient investments and spatial planning and disaster risk financing.	FY16-FY20	http://projects.worldbank.org/P154840/?lang=en&tab=overview
World Bank	Regional	Pacific Resilience Program	A program of support for SPC to support PICs with early warning, preparedness and response, resilient investments and spatial planning and disaster risk financing in the Pacific.	FY16-FY20	http://projects.worldbank.org/P147839?lang=en
World Bank	Tonga	Tonga Cyclone Ian Reconstruction and Climate Resilience Project	This project aims to rebuild communities and strengthen Tonga's resilience to natural disasters.	FY14-FY18	http://projects.worldbank.org/P150113?lang=en
WMO	Regional	Strengthening Hydro-Meteorological and Early Warning Services in the Pacific (proposed)	This project aims to strengthen the RSMC in Fiji to support PICs and to develop PIC meteorological capacity for impact-based forecasts of extreme weather events. It is part of the Climate Risk Early Warning Systems (CREWS) initiative.	FY18-FY22	https://public.wmo.int/en/media/press-release/climate-risk-and-early-warning-systems-prioritize-most-vulnerable
WMO	Regional (9 PICs including Tonga)	Severe Weather Forecasting Demonstration Project	This project aims to strengthen capacity of NMSs to deliver improved forecasts and warnings of severe weather to save lives and livelihoods, and protect property and infrastructure.	FY16-FY19	http://www.wmo.int/pages/prog/www/swfdp/

Appendix 2: 2014 Tonga EWS Needs Assessment

1. Key Findings and Recommendations

Finding 1: While the current arrangements in place for data and information sharing appear adequate, they appear to be ad hoc and would benefit from more formal regulation.

Recommendation 1: Review and revise existing legislation that provides the regulatory framework for warning and response including data sharing, the issuance of warnings and the expected response from local officials and communities. The importance of “self-rescue” needs to be emphasised within communities.

Finding 2: While there is always room to improve weather forecasts and warnings, TMS provides a high level of service, utilising national and regional sources of data.

Recommendation 2: Ongoing support for training is essential to maintain currency of staff and to introduce new techniques to improve forecasts and warnings.

Finding 3: Representatives of sectors impacted by hazards do not necessarily have in place adequate coping mechanisms and may not always heed advice and warnings from TMS.

Recommendation 3: Make training workshops available to sectors to improve their capacity to respond appropriately to hazard warnings. This would also encourage international organisations to cooperate more effectively with Tonga authorities, such as TMS and NEMO.

Finding 4: Communication between TMS headquarters and TMS stations, NRD, NEMO, emergency services and the public on remote islands and mariners is inadequate to ensure essential information is conveyed to those that need it.

Recommendation 4: Upgrade the marine HF radio network and the VHF network to communicate with communities. A common frequency for information sharing between civil, military and other responders is essential. This would also improve communication among TMS, NRD and NEMO.

Finding 5: The Geo-hazards monitoring and visualisation tools are limited.

Recommendation 5: Upgrade the operational facilities used to monitor and visualise geo-hazards, and ensure continuity of operations by mirroring capabilities outside of high risk zone; for example, by co-located services with TMS at the airport.

Finding 6: The TMS facilities at its headquarters need to be repaired or replaced.

Recommendation 6: Upgrade the operational facilities at TMS headquarters at the airport or another location.

Finding 7: The NEMO headquarters is located in a hazard zone and risks operational failures in the event of a tsunami or major storm surge.

Recommendation 7: If for operational reasons, NEMO is to remain at its current location attention needs to be paid to minimise failure of the operations center in the event of damage from debris flows

commonly associated with tsunami wave-fronts. Where possible back-up systems should be located with TMS at the airport, so that NEMO could re-locate to this location in the event operations at the existing facility is compromised. This would also be the likely center of any relief operations following a major disaster. Alternatively, TMS, NEMO and seismic monitoring operations of NRD could be co-located in a new facility outside of the Tsunami zone, but closer to existing government facilities. Consideration should be given to relocating all government activities to a safe zone to ensure continuity of operations.

Finding 8: Despite good severe weather forecasts and warnings, the population does not fully understand the information communicated to them often resulting in an inadequate response.

Recommendation 8: Introduce impact-based forecast and warning services as a part of a revised Multi Hazard Early Warning System. This would include building tools designed to take into account vulnerability and exposure information.

Finding 9: Vulnerability mapping has been a critical effort of NRD. This is an ongoing effort that needs to be sustainable since vulnerability assessments need to be updated frequently. This effort needs to be comprehensive to ensure all aspects of vulnerability are captured. Much has already been done in this area: this should be reviewed and updated. All available data should be made available to the Government of Tonga.

Recommendation 9: Ongoing vulnerability assessments should be supported. This includes mapping the natural environment as well as infrastructure assessments (roads, residential, public and commercial buildings).

Finding 10: Despite best efforts, public education of hazard risks is limited.

Recommendation 10: An ongoing and frequently repeated education campaign is needed including television, production of educational videos, etc. A TV weather studio should be created, which would serve the purpose of providing daily broadcasts of weather, as well as educational programming. This could be developed jointly by TMS, NRD, and NEMO. Programming should be designed to reach all of the Kingdom's people. Frequent drills would also accompany this and other activities designed to increase the capacity of the public to respond to an emergency appropriately.

Finding 11: On the 01 October 2014, Pacific Tsunami Warning Center (PTWC) will no longer issue warning/watch bulletins requiring all Pacific Island Countries including Tonga to undertake their own threat assessments and issue warnings.

Recommendation 11: Strengthen the capability of national tsunami warning centres to undertake their own threat assessments using either the new PTWS information products or expanding the tsunami model to include other islands and scenarios. This is a critical activity, which should be undertaken in partnership with other PICs in the region.

Finding 12: The seismic monitoring network is not fully integrated into the regional network and some equipment is outdated.

Recommendation 12: Upgrade and expand the seismic observing network.

Finding 13: Tonga participates in a number of regional WMO programs to improve severe weather forecasts and storm surge forecasts.

Recommendation 13: Adequate resources should be available for operational training related to these regional activities either as part of recommendation 2 or as a separate regional effort.

2. Country Assessment

Background

The World Bank team conducted meetings with 'Ofa Fa'anunu, Head of the Tonga Meteorological Services (TMS) and Leveni 'Aho, Director of the National Emergency Management Office (NEMO) in the Ministry of Environment, Energy, Climate Change, Disaster Management, Meteorology, Information and Communications, and Taaniela Kula, Head of Natural Resources Division (NRD), Ministry of Lands and Natural Resources.

The aim of this assessment is to validate gaps, which have been identified in the capacities of these agencies to minimise the adverse impacts of meteorological and geophysical hazards (hereafter natural hazards), which can result in disasters that affect the entire economic, human, and physical environment and impact the long-term development of the Kingdom of Tonga.

Although relatively small, the TMS has qualified staff (Class 1 Meteorologists), operating 24 hours by 7 days (24/7), to provide a full range of weather forecasts and warnings, TMS is also responsible for providing warnings of tsunamis based on data provided by Natural Resources Division. The latter has recently started 24/7 monitoring of earthquakes to ensure the warning system is able to meet the requirements of the population. Staffing levels prevent TMS from supporting aviation meteorological services, which are provided by the Fiji Meteorological Service.

TMS maintains meteorological staff (observers) at 5 synoptic stations (a sixth station is in the process of being installed) covering the territory of the Kingdom of Tonga. This is critical for communication of warnings to the public in remote locations. TMS is headquartered at the domestic terminal of Fua'amotu Airport. This is a relatively secure location because of its elevation, unlikely to be directly impacted by a tsunami or storm surge, however, the current building is unlikely to withstand a Category 2 Tropical Cyclone. NRD and NEMO are located adjacent each other within Nuku'alofa in an area designated as vulnerable to the impact of a tsunami. Neither building is constructed to withstand extreme weather or water damage.

Multi Hazard Impact-Based Forecast, Warning and Response System

Multiple threats require an integrated response. This has led to the development of so-called Multi Hazard Early Warning Systems (MHEWSs), although there is no commonly accepted approach to achieve a functional operational system. The World Meteorological Organisation (WMO) and the Global Facility for Disaster Reduction and Recovery (GFDRR) have favored an approach developed by the Shanghai Meteorological Service and now adopted by the City of Shanghai, China (Tang et al. 2012) and by WMO as a global good practice. The system is structured in such a way that decisions are optimised to minimise delays in communication and effective action. On its own however, this system does not guarantee that those threatened by a natural hazard understand the warning, their vulnerability and exposure, and consequently the risk they face.

The response to Tropical Cyclone Ian illustrates this point. Despite receiving warnings and frequent updates from TMS on the worsening weather situation, people did not evacuate to designated safe areas until their homes were destroyed, unnecessarily risking their lives.

A new approach is needed that emphasises weather impacts, rather than conveying technical information about the weather itself. This evolution from forecasting what the weather will be to forecasting what the weather will do is now a high priority of the WMO Public Weather Services to ensure that advances in weather forecasting result in greater public safety and security.

The foundation of this approach is the extension of well-functioning hazards forecast and warning system to an impact-based forecast and warning system. This requires access to information on the vulnerability and exposure of those at risk. It is also an opportunity to monitor the response of the public if communities and individuals can feedback information on the actions they have taken to reduce their exposure. In this way, emergency operations can be better informed about the changing risk of impact through the course of an event, enabling the limited resources of the emergency services to be targeted to those most in need.

Gaps and Recommendations

While many aspects of such of end-to-end impact forecast, warning and response system are in place; some gaps need to be addressed. These include:

Introducing an Impact-Based Forecast and Warning System

There is a need to introduce and develop an impact-based forecast and warning system based on the latest World Meteorological Organisation (WMO) guidelines. In many regions of the world forecasts and warnings of hazards have become very reliable, but this has not necessary resulted in more lives saved. Understanding the impact of weather, for example, is much more critical than understanding the weather. In Tonga, while there is a high degree of skill in meteorological forecasts and warnings, translating these forecasts and warnings into impacts is limited. A critical component of any effective warning system is the ability to understand the warning and take effective action. This requires greater emphasis on understanding vulnerability and exposure of everyone and providing individuals with the means to take effective action to reduce their own exposure. In Tonga, there is the recognition that impact-based forecasts and warning are needed. The capacity to do this requires an effort to capture sufficient information on vulnerability and exposure and to build the impact-based forecast and warning system into the MHEWS that, in addition to hazard warnings, facilitates effective communication of impacts and enables an informed response. The same system would also help emergency services target their response to those most at risk. It would also be used to monitor changes in impact risks as the hazard evolves and exposure is reduced, through adequate sheltering, for example.

Partnerships for Data Sharing

A system that focuses on impacts requires significantly more information than is routinely available to meteorologists. Partnerships among agencies should, wherever possible, be formalised so that critical data are always available. It is recommended, therefore, that existing legal frameworks be reviewed with the aim of revising regulations and institutional arrangements to facilitate the exchange of data and information among agencies required for a fully operational multi-hazard impact-based forecast,

warning and response system. Such a framework is usually implemented through a set of bilateral agreements among the stakeholders.

All Hazards

The impact-based forecast, warning and response system needs to consider all contingencies and therefore needs to include all likely hazards, both natural and as a consequence of human actions, such as congestion on highways due to an evacuation or breakdown in communication due to local customs and behaviors. Determining this would require extensive discussions between all national stakeholders resulting in the identification of a set of hazards and vulnerabilities that need to be quantified and included.

Facilities

TMS, NHD, and NEMO operate in three separate facilities. The location of NRD and NEMO are within a tsunami impact zone and therefore there is a high risk of inundation and damage during an event. The TMS is located at the airport, which is safely above the risk of inundation due to a tsunami, but vulnerable to damage by a category 2 tropical cyclone or greater. It is recommended that TMS, the seismic monitoring functions of NHD and the emergency operations center functions of the NEMO co-locate in a new purpose built facility. This would help ensure continuity of operations for all three activities.

Observations

The seismic network is not fully operational and not reporting to the regional network. Upgrading and enhancing this network would improve the capability of NRD to monitoring local earthquakes enabling earliest alerting of the risk of a locally generated tsunami.

Training

New way of working requires appropriate levels of training. Training should be available to all of the participating agencies to improve their understanding of warning services and their ability to develop the appropriate communication tools to convey actionable warning information. Training is required to increase skills for the development of applications; support ICT; provide technical support; and develop interfaces to translate scientific information. Introducing impact-based forecast and warning systems would require extensive training and would benefit from twinning arrangements with the institutions leading the development of these skills. These activities are common to all participating PICs.

Visualisation Tools

Investment is needed in protocols and visualisation tools; for example, the ability to display real-time maps of hazard warnings and impact warnings based on a common color-coded system, which is consistent for all hazards and impacts. Existing development partner support is contributing to this type of system, but additional effort is required to create an effective public interface for a MHEWS. This system would consist of a warning dissemination system able to communicate hazard impact warnings with DRR stakeholders, media, communities and individuals through new technology platforms (e.g. mobile phone application, web platform).

The need for a MHEWS is common to all PICs. Therefore, a regional approach to defining warning thresholds, color-coding of warning levels, and common symbols is recommended. Responsibility for hosting the servers supporting Web-based visualisation tools would be distributed among all of the participating countries to ensure continuity of operations.

Communication

Communication with remote islands is critical in Tonga to distribute warnings and enable two-way communication on impacts and recovery. The preferred means of communication is HF and VHF radio. This system would consist of a two-way communication system to give the opportunities to exchange efficiently timely warnings and receive feedback from communities on the current threat for better Disaster Risk Management from the NEMO.

Regional Integration

Better integration into regional organisation need to be considered for the MHEWS, as an operational component of the existing WMO regional institutions and systems (e.g., Regional Specialised Meteorological Center Nadi, Regional Specialised Meteorological Center Wellington, and the WMO Severe Weather Forecasting Demonstration Project (SWFDP)) and the WMO Coastal Inundation Forecasting Demonstration Program, in which the NMS already participates.

Seismological monitoring has been integrated into the Oceania Regional Seismic Network (ORSNET) and needs to be further strengthened with addition of new sensors.

Although each of these relationships is governed by international conventions (e.g., WMO), specific details on data sharing, continuity of operations, communications, etc. tends to be ad hoc. MOUs are recommended to formalise some of these regional relationships to assure continuity of operations.

Community Preparedness and Response

Community preparedness and response needs to be strengthened to include natural hazard risk considerations. Technical advice from TMS and NRD on these can strengthen the approaches used by agencies working with communities. Consultations with all communities in Tonga were undertaken in 2009 to identify community focused priorities for implementation under the Joint National Action Plan for DRM and CCA. Those priorities are being implemented by a number of community-based agencies and partners. There is still a need to harmonise the support by various partners to reduce duplication, maximise resources made available for community implementation and ensure the approach used is complementary to advice being provided by NEMO. The approach used is particularly important when working with communities to address natural hazard related risks including the development of response procedures that correlate to warnings disseminated from the warning centre.

Comprehensive vulnerability and risk assessments need to be done for a range of hazards across all the islands. Tsunami modeling has been completed for Tongatapu and used in community tsunami evacuation planning. Similarly, consultations with communities on Lifuka were also held to identify acceptable mitigation options to future storm surge impacts. These activities can strengthen community capacity to prepare for and respond to natural hazard impacts and also identify suitable evacuation centers. An evaluation of the structural integrity and capacity of identified evacuation centres will need to be undertaken and recommendations for improvement provided to Government.

3. Proposed Investment

The proposed investment considered here consists of two subcomponents focused on early warning and preparedness and community resilience. The needs assessment identified several areas requiring investment to strengthen the interpretation and communication of warning information and to improve the capacity of more communities to respond effectively to warnings.

Component 1: Early Warning, Preparedness and Resilience

The objective of this component is to increase the resilience of each participating country, and the region as a whole, to meteorological and geophysical hazards. This component has two sub-components: (i) Early Warning and Preparedness, and (ii) Resilient Investments.

Sub-Component 1.1: Early Warning and Preparedness

Sub-component 1.1 will strengthen the following key elements: (i) detection, forecasting and warning of natural hazards; (ii) dissemination of timely warning to the population, including last mile communication; and (iii) emergency preparedness and response mechanisms.

Investments under this sub-component will form an end-to-end multi-hazard warning and response system that considers the combined threats posed by all potential hazards based on an understanding of the vulnerability of people, assets and their specific exposure. Ensuring people take appropriate life-saving steps requires forecasts and warnings that are easily understood and actionable. Historically, all National Meteorological and Hydrological Services (NMHSs) have featured forecasting of the weather, hydrology, and climate events as central to their mission, and many also issue warnings in the case where hazardous weather, hydrological, climate and geological events are expected. Usually, in the case of both weather forecasts and warnings, the focus is on what the weather will **be**. This project will help Tonga Meteorological Services evolve from this weather-based paradigm to one that is focused primarily on forecasting impacts. In other words, the focus should evolve to what the weather will **do**. The same paradigm shift would also apply to hydrological, climate and geohazard forecasts and warnings within this program.

The Tonga Meteorological Services (TMS) and the National Emergency Management Office (NEMO) are part of the Ministry of Environment, Energy, Climate Change, Disaster Management, Meteorology, Information and Communications, and together with the Natural Resources Division (NRD) of Ministry of Lands and Natural Resources monitor, forecast, warn and respond to meteorological and geophysical hazards. TMS is responsible for meteorological forecasts and warnings, as well as tsunami warnings based on data provided by NRD.

Cooperation between TMS, NRD and NEMO is well developed enabling rapid dissemination of warnings and early handling of emergency situations. This is ensured by distinct and well-defined roles and responsibilities for each entity.

The principle concern is continuity of operations in case of tsunami impact on NRD and NEMO, which would compromise their capability, and the risk of destruction of the TMS offices in the case of Category 2 or greater tropical cyclone.

Tonga faces multiple threats from natural hazards and the consequential cascading threats, such as contamination of water supplies, disruption of connections between communities, loss of electrical power, disease outbreaks and so forth. Tongan society needs to be well informed about the actions to take to minimise the risk of loss of life, livelihoods and property.

The TMS has indicated the need to implement warning services based on a Multi Hazard Early Warning System (MHEWS). The program will focus on expanding this capability to include forecasts and warnings of meteorological, hydrological and geological impacts. This would enable those at risk, and those responsible for public safety and economic security, to know exactly what actions to take.

The MHEWS depends on good meteorological, hydrological and seismological forecasts, as well as cooperation among a large number of stakeholders, some of whom are expected to supply critical data to underpin the impact warning service as well as issuing warnings within their area of responsibility. For example, the ministry responsible for schools may be tasked to issuing specific directives to protect the lives of children; the highways agency may provide warnings to avoid potential loss of life and property on damaged roads and bridges; the same agency may also be responsible for electricity supply and would provide warnings of the risk of electrical hazards associated with damaged power-lines. These examples highlight the need for a high level of cooperation among government agencies and civil society in general to sustain a resilient society. Effective Standard Operating Procedures (SOPs) are a critical element of the MHEWS.

In addition to introducing impact-based forecast and warning services, TMS needs to expand its capabilities to include coastal inundation forecasts to minimise the impact of storm surges and continue to improve its forecasting of severe convective weather events. The observational networks for meteorology, hydrology and seismology required to achieve these improvements will also be strengthened partially through this project and other development partner support. The project will also help enhance participation in the WMO Severe Weather Forecasting Demonstration Project and the WMO Coastal Inundation Forecasting Demonstration, as well as strengthen operational ties with the Pacific Tsunami Warning Center and the WMO Regional Specialised Meteorological Centers in Nadi and Wellington, and with other regional bodies that can assist with training and capacity building.

The subcomponent will improve the quality of forecasting and warning services by providing i) a stronger institutional and regulatory framework; ii) modernising the observing and forecasting infrastructure; and iii) enhancing the services TMS delivers to the public and to its partners.

A. Institutional and regulatory strengthening, capacity building and implementation support

This subcomponent aims to strengthen the legal and regulatory framework of TMS, NRD, NEMO and their partners to exchange data and information critical for the implementation of impact-based forecast and warning services as an integral part of a MHEWS. Experience elsewhere suggests that an operational partnership between stakeholders would be needed that may go beyond current institutional arrangements. It will also be necessary to build capacity with the TMS, NRD, and NEMO, and among stakeholders to ensure the operability of the future systems, and to support project design and implementation. There are three parts:

- A.1) Institutional strengthening and development of a legal and regulatory framework, which includes (1.1) Institutional development and strategic planning, review and revision of legal and regulatory frameworks for TMS, NRD, NEMO and other key partners' operations including the revision and/or development of standard operating procedures (SOPs); and (1.2) twinning support to enable TMS to work closely and sustainably with more advanced National Meteorological and Hydrological Services (NMHSs) and the WMO.
- A.2) Capacity Building and Training, which includes (2.1) developing and implementing a capacity building and training program consisting of (a) Personnel training and retraining; professional orientation for senior staff, and study tours; and (b) training in WMO Regional Training Centers, WMO RSMCs, PTWC and other regional entities as needed; and (2.2) implementing training activities (workshops, round tables, etc.) for major users of warning services (e.g., provincial disaster management, agriculture, water resources, energy, health, surface transportation).
- A.3) Systems design and integration, component management and monitoring, which includes (3.1) detailed design of the updated MHEWS systems and support for implementation (Systems Integrator Consultant); and (3.2) project management, monitoring, reporting and evaluation of subcomponents A, B, and C.

B. Modernisation of the Observation Infrastructure, Data Management Systems, Forecasting and Warning Systems

This subcomponent focuses on expanding NRD seismic network, developing the MHEWS, upgrading of the communication networks, data management, and construction of new facilities for monitoring, warning and response operations. This subcomponent has four parts:

- B.1) Technical modernisation of the observation networks, which includes (1.1) expansion of the seismic observation network including GPS. The modernised observation network must be capable of being fully integrated with any existing observing systems.
- B.2) Upgrade of data management, communication, and IT systems, which includes: (2.1) Marine and community communication infrastructure (HF and VHF) for TMS, NRD and NEMO; and (2.2) data management systems capable of fully integrating all sources of data including existing and future national observing networks, and forecast products, and with backup capability within the TMS and NRD.
- B.3) Development of the MHEWS, which includes: (3.1) Computers, software and visualisation tools for computation of impact-based forecasts and warnings including displays at NEMO and NRD; and (3.3) computers, software, furniture, generators for the Seismic Operations Center at NRD.
- B.4) Reconstruction and refurbishment of facilities, which includes: (4.1) TMS; and (4.2) NRD Seismic Operations Center and NEMO emergency operations center.

C. Enhancement of the MHEWS Service Delivery System

The objective of this subcomponent is to improve service delivery by enhancing the MHEWS to include impact-based forecast and warning services that delivery actionable information to the public at risk and to emergency services. There are two main tasks:

- C.1) Expansion of the MHEWS services to sectors, which includes (1.1) developing, improving and operationalising new information services; (1.2) improving the means of delivering services to communities and individuals including the development of new mobile applications; and (1.3) providing feedback from users on the quality of services through public and sector specific surveys.
- C.2) Support of MHEWS including impact-based forecasts and warnings, which includes: (2.1) developing SOPs, warning protocols and signals agreed with all stakeholders (2.2) Operational training and drills with government stakeholders and communities; (2.3) Vulnerability assessments for each identified hazard and for the entire country; and (2.4) introducing and pilot testing (jointly with DRM agency) of impact-based forecasting techniques and warnings.

Sub-Component 1.2: Resilient Investments

This subcomponent will identify priority investments in physical resilience and public asset retrofitting with a view to supporting community preparedness and response efforts.

The tasks include:

- a. Training for community based organisations and national agencies working with communities to include natural hazard risk considerations.
- b. Support to develop and test for each community evacuation plans and procedures that identify suitable shelters and safe evacuation routes. Evacuation procedures will need to be congruent with warnings issued from the warning center.
- c. Retrofitting of public facilities, in particular schools and health facilities, identified as community evacuation centers to ensure that they conform to the national building code and meet the requirements of an emergency shelter.

Regionally Supported Activities

Several of the project activities depend on regional cooperation and would provide a common warning platform for all participating countries. These include the following:

Activity	
A1.2	“Twinning” operational support from WMO (SWFDP, FFG, Impact-based Forecasting, MHEWS)
A2.1	Developing and implementing capacity building training program
A3.1	Detailed design of the MHEWS systems, procurement and implementation support (Systems Integrator Consultant)
C1.1	Development, improvement and operationalisation of production of basic and specialised information products
C2.1	Development of SOPs, warning protocols and signals agreed with all stakeholders
C2.3	Vulnerability assessments for each identified hazard

Appendix 3: Overview of the Pacific Resilience Program (PREP) in Tonga

The Pacific Resilience Program (PREP) is a World Bank program of support for early warning, preparedness and response, resilient investments and spatial planning and disaster risk financing in the Pacific. PREP Phase 1 was approved by the World Bank in June 2015 and will offer support through to November 2020.

The objective of the PREP is to strengthen early warning, resilient investments and financial protection of participating countries. Working with multiple PICs, within a regional framework, will allow the introduction of good practices in MHEWSs, introduce impact-based forecast and warning services, and streamline warning and response coordination.

The expected outcomes include a common, easy to understand multi hazard warning system; greater understanding of the impact of hazards by people at risk and therefore more effective response enabling communities to “self-rescue” mitigating potential disasters; and greater cooperation among PICs to improve the accuracy and timeliness of forecasts and warnings.

PREP comprises four components outlined below:

- (i) **Component 1: Strengthening Early Warning and Preparedness** – This component aims to increase the resilience of Tonga and the Pacific region as a whole to natural hazards such as cyclones, coastal/riverine flooding, volcanoes, tsunamis and earthquakes by improving the quality of forecasting and warning services.
- (ii) **Component 2: Risk Reduction and Resilient Investments** – This component supports a multi-sectoral planning process for integrating climate and disaster risk and resilience into development.
- (iii) **Component 3: Disaster Risk Financing** – This component will provide immediate, yet limited post-disaster support to help Tonga and the region as a whole improve their post-disaster financial response capacity. This will be done through the implementation of an integrated disaster risk financing and insurance strategy which builds on a cost-effective combination of national and regional financial instruments to address the liquidity needs of post-disaster response, following events of low, medium and high severity. This builds on the Pacific Catastrophe Risk Insurance pilot.
- (iv) **Component 4: Project and Program Management** – This component will provide efficient and effective implementation support to the project, including staff, operating costs, monitoring and evaluation, and the cost of audits. It will also provide efficient regional coordination of the different country Projects and the implementation of activities that will be executed at the regional level.

The total cost of the PREP Phase I is estimated to amount to US\$45.69 million over 5 years. A breakdown of the costs overall and specifically for Tonga are outlined in Table 1 below.

Table 1: Program Cost, Phase I

Component and/or Activity	Program Cost (US\$M)	Regional Cost (US\$M)	Tonga Project (US\$M)
1. Strengthening Early Warning and Preparedness	22.998	2.287	11.461
1.1. Investments in early warning and preparedness	20.711		11.461
1.2. Regional TA to strengthen impact forecasting and preparedness	2.287	2.287	
2. Risk Reduction and Resilient Investments	8.587	5.712	1.725
2.1. Risk reduction and resilient investment planning and preparation	2.875		1.725
2.2 Regional platform to support risk reduction and resilient investment planning	5.714	5.712	
3. Disaster Risk Financing	9.380	0.750	2.680
3.1 Disaster risk financing instruments	8.630	-	2.680
3.2 Development of Mutual Insurance Fund	0.750	0.750	
4. Project and Program Management	4.731	2.945	0.893
4.1. Project management	1.785		0.893
4.2. Regional Program Management and Coordination	2.945	2.945	
TOTAL COSTS	45.696	11.694	16.759

Note: Figures may not add up due to rounding.

PREP comprises a combination of nationally implemented activities and regional implemented activities as described in the matrix below:

	National Implemented Activities	Regional Implemented Activities
Recipients	✓ Phase I countries: Samoa and Tonga, with RMI and Vanuatu for premium financing under sub-component 3.1.2.	✓ SPC for Component 1.2, 2.2 and 4.2 ✓ PIFS for component 3.2 and 4.2
Component 1: Strengthening early warning and preparedness	✓ 1.1 Investments in early warning and preparedness	✓ 1.2 Regional Technical Assistance (TA) to strengthen impact forecasting and preparedness
Component 2: Risk Reduction and Resilient Investments	✓ 2.1 Risk reduction and resilient investment planning and preparation (including entry level investments)	✓ 2.2. Regional platform to support risk reduction and resilient investment planning
Component 3: Disaster Risk Financing	✓ 3.1. Disaster risk financing instruments	✓ 3.2 Development of Mutual Insurance Fund
Component 4: Project and Program Management	✓ 4.1 Project Management	✓ 4.2 Regional Program Management and Coordination

Management.		
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The PREP is aligned with the following government documents for Tonga - the Government of Tonga (GoT) Joint National Action Plan on Climate Change and Disaster Risk Management (2010-2015) and the National Infrastructure Investment Plan (under the Pacific Region Infrastructure Facility). In addition, PREP complements and builds on the themes in Tonga's Strategic Program on Climate Resilience (SPCR) for PPCR, including mainstreaming of climate resilience in key strategies, policies and infrastructure, as well as strengthening civil society and community engagement. The PREP is also consistent with the Tonga Country Assistance Strategy (CAS) FY10-14.

The PREP will build synergies with existing initiatives which aim to minimise the impact of climate change and natural hazards in Tonga. These include: (i) the Strategic Program for Climate Resilience, under the Tonga Pilot Program for Climate Resilience (PPCR); and (ii) the World Bank funded Tonga Cyclone Ian Recovery and Climate Resilience Program.

Further information about the PREP, including the Project Appraisal Document (PAD), is available at: <http://www.worldbank.org/projects/P154840/?lang=en&tab=documents&subTab=projectDocuments>

For further information about PREP, please contact:

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Appendix 4: Reference List

- Australian Department of Foreign Affairs and Trade (DFAT). 2016. *Stocktake of Early Warning Systems in the Pacific*. Available upon request from Ms Paula Claudianos, email: paula.claudianos@dfat.gov.au.
- Australian Department of Foreign Affairs and Trade (DFAT). 2015. *DFAT Management Response to the COSPPAc Independent Progress Review*. Available at: <http://dfat.gov.au/about-us/publications/Pages/pacific-climate-oceans-support-program-ind-prog-review.aspx>
- Davidson, Jim and M.C. Wong. 2005. *Guidelines on Integrating Severe Weather Warnings into Disaster Risk Management*. Available at: http://library.wmo.int/pmb_ged/wmo-td_1292.pdf
- Kingdom of Tonga. 2010. *Joint National Action Plan on Climate Change Adaptation and Disaster Risk Management: 2010-2015*. Available at: <https://sustainabledevelopment.un.org/content/documents/1335tongaDisaster%20Management%20Strategy.pdf>
- Kingdom of Tonga. 2009. *Tonga Emergency Management Plan*. Available at: https://www.humanitarianresponse.info/system/files/documents/files/TON_National%20Emergency%20Management%20Plan%202009.pdf
- Kingdom of Tonga. 2007. *Emergency Management Act 2007*. Available at: http://www.preventionweb.net/files/30948_tongaemergencymanagementact2007.pdf
- Pacific Island Forum Secretariat (PIFS). 2016. *Framework for Resilient Development in the Pacific: An Integrated Approach to Address Climate Change and Disaster Risk Management*. Available at: <http://www.forumsec.org/resources/uploads/embeds/file/Annex%201%20-%20Framework%20for%20Resilient%20Development%20in%20the%20Pacific.pdf>
- Rogers, David and Tsirkunov, Vladimir. 2013. *Weather and Climate Resilience: Effective Preparedness through National Meteorological and Hydrological Services*. GFDRR. Available at: https://www.gfdr.org/sites/gfdr.org/files/publication/Weather_and_Climate_Resilience_2013.pdf
- Rogers, David and Tsirkunov, Vladimir. 2011. *Implementing Hazard Early Warning Systems*. GFDRR. Available at: http://www.preventionweb.net/files/24259_implementingearlywarningsystems1108.pdf

Secretariat Pacific Regional Environment Programme (SPREP). 2012. *Pacific Islands Meteorological Strategy 2012–2021: Sustaining Weather and Climate Services in Pacific Island Countries and Territories*. Available at: <https://www.sprep.org/publications/pacific-islands-meteorological-strategy-2012-2021>

Tang, Xu, Lei Feng, Yongjie Zou, and Haizhen Mu. 2012. “The Shanghai Multi-Hazard Warning System: Addressing the Challenge of Disaster Risk Reduction in an Urban Megalopolis.” In *Institutional Partnerships in Multi-Hazard Early Warning Systems*, edited by Maryam Golnaraghi, 159–79. Heidelberg, Germany: Springer.

United Nations Development Programme. 2016. *Risk Governance – Building Blocks for Resilient Development in the Pacific*. Available at: <http://www.pacific.undp.org/content/dam/fiji/docs/PRRP%20Risk%20Governance%20Policy%20Brief.pdf>

United Nations University. 2016. *World Risk Index Report*. Available at: <http://weltrisikobericht.de/wp-content/uploads/2016/08/WorldRiskReport2016.pdf>

World Bank. 2017. *Pacific Possible – Long-term economic opportunities and challenges for Pacific Island Countries*.

World Bank. 2013. *Strong, Safe and Resilient: A strategic policy guide for disaster risk management in East Asia and the Pacific*. Abhas Jha and Zuzana Stanton-Geddes, eds. Available at: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2015/07/10/090224b0828c86a8/1_0/Rendered/PDF/Strong00safe000Asia0and0the0Pacific.pdf

World Bank. 2013. *Weather and Climate Resilience- Effective Preparedness through National Meteorological and Hydrological Services*. David Rogers and Vladimir Tsirkunov. Available at: <https://openknowledge.worldbank.org/bitstream/handle/10986/15932/81113.pdf?sequence=1>

World Bank. 2011. *PCRAFI Country Note: Tonga*. Available at: <http://pcrafi.sopac.org/documents/526/download>

World Meteorological Organisation (WMO). 2015. *WMO Guidelines on Multi-hazard Impact-based forecast and warning services*.⁷ Available at: https://www.wmo.int/pages/prog/www/DPFS/Meetings/ET-OWFPS_Montreal2016/documents/WMOGuidelinesonMulti-hazardImpact-basedForecastandWarningServices.pdf

⁷ Note that at the time of undertaking the country needs assessments the WMO Guidelines on Impact Forecast and Warning Services (2014) was referenced. This document was updated in 2015 and hence the latest guidelines have been referenced above.

Appendix 5: List of external stakeholders consulted in 2016

Organisation	Name	Position Title	Email
DFAT	Ms Paula Claudianos	Senior Policy Officer, Pacific Analytical and Effectiveness Branch	paula.claudianos@dfat.gov.au
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